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FortiOS™ Handbook - Carrier

Version 5.6.2

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FortiOS™ Handbook - Carrier

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Change Log

Date	Change Description
2017-09-06	Initial publication of 5.6 version

Introduction

FortiOS Carrier provides all the features found on FortiGate units plus added features specific to carrier networks. These features are explained in this document and include dynamic profiles and groups, Multimedia messaging service (MMS) protection, and GPRS Tunneling Protocol (GTP) protection.

This chapter contains the following sections:

Before you begin

Before you begin ensure that:

- You have administrative access to the web-based manager and/or CLI.
- The Carrier-enabled FortiGate unit is integrated into your network.
- The operation mode has been configured.

How this guide is organized

This FortiOS Handbook chapter contains the following sections:

- What's New in FortiOS 5.6
  - Features and improvements that have been added in version FortiOS 5.6
- Overview of FortiOS Carrier features
  - The high altitude overview of FortiOS Carrier
- "MMS Concepts" on page 18
  - Basic background on MMS and its concepts so that there is some context to the settings used in the MMS configuration
- "MMS Configuration" on page 34
  - Listing of the MMS configuration options and settings
  - Procedures and insights in the configuration of the MMS components of FortiOS Carrier
- GTP basic concepts
  - Basic background on GTP and its concepts so that there is some context to the settings used in the GTP configuration
- "GTP Configuration" on page 101
  - Listing of the GTP configuration options and settings
  - Procedures and insights in the configuration of the GTP components of FortiOS Carrier
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- "Troubleshooting" on page 146
  - Some basic procedures for troubleshooting FortiOS Carrier

What's New in FortiOS 5.6

New features added in 5.6.3

Improved CLI attribute name under 'gtp.message-filter-v0v1' (452813)

CLI "`gtp.message-filter-v0v1`" had an attribute "`create-aa-pdp|init-pdp-ctx`", which contains a vertical pipe |. The attribute name was changed to "`v0-create-aa-pdp--v1-init-pdp-ctx`".

Its help text is also changed to avoid the vertical bar.

Syntax

```
config gtp message-filter-v0v1
   edit <name>
      set ?
         ......
         v0-create-aa-pdp--v1-init-pdp-ctx
```

Improved GTP performance (423332)

There are independent Receive and Transmit queues for `gtp-u` process. These queues are and their associated resources are initialized when the ftp-enhance-mode is enabled.

CLI changes under system npu

gtp-enhance-mode

```
config system npu
   set gtp-enhance-mode [enable|disable]
   end
```

This configuration requires a reboot of the device to initialize the changes.

gtp-enhance-cpu-range

This is used to set the CPUs which can process the GTP-U packet inspection.

```
config system npu
   set gtp-enhance-cpu-range [0|1|2]
   end
```

Option	Description
0	Inspect GTPU packets by all CPUs
1	Inspect GTPU packets by Master CPUs
2	Inspect GTPU packets by Slave CPUs

New diagnose commands

diagnose npu np6 hbq-stats [all|np xx]

Used to see the GTP-U packet counter by all NP or the corresponding np.

diagnose npu np6 hbq-stats-clear all /np xx

Used to clear the GTP-U packet counter by all NP or the corresponding np.

Verifying the enhance-mode is disabled

Before execute the test or enable/disable the gtp enhance, first check the gtp-enhance-mode status as in the example below:

```
config system npu
   get
   gtp-enhance-mode: disable
   gtp-enhance-cpu-range: 0
   end
```

If the `gtp-enhance-mode` is `disable`, use the command `diagnose npu np6 hbq-stats all`.

The output will be similar to below:

```
# diagnose npu np6 hbq-stats all
Total :0
```

If the `gtp-enhance-mode` is `enable`, use the command `diagnose npu np6 hbq-stats all`

The output will be similar to below:

```
# diagnose npu np6 hbq-stats all
cpu_ 0:0
cpu_ 1:0
cpu_ 2:0
cpu_ 3:0
cpu_ 4:0
cpu_ 5:0
cpu_ 6:0
cpu_ 7:0
cpu_ 8:0
cpu_ 9:0
cpu_10:0
cpu_11:0
cpu_12:0
cpu_13:0
cpu_14:0
cpu_15:0
cpu_16:0
```

```
cpu_17:0
cpu_18:0
cpu_19:0
cpu_20:0
cpu_21:0
cpu_22:0
cpu_23:0
cpu_24:0
cpu_25:0
cpu_26:0
cpu_27:0
cpu_28:0
cpu_29:0
cpu_30:0
cpu_31:0
cpu_32:0
cpu_33:0
cpu_34:0
cpu_35:0
cpu_36:0
cpu_37:0
cpu_38:0
cpu_39:0
Total :0
```

Sometimes, when loading the new configure file, and the new configure file does not match the old configure file, the `gtp-enhance-mode` status will be confused.

You can see :

```
#config system npu
#get
gtp-enhance-mode: enable
```

but you can also see that

```
diagnose npu np6 hbq-stats all
Total :0
```

This means the `gtp-enhance-mode` is actually set to `disable`.

The inverse is also possible, when you see

```
#config system npu
#get
gtp-enhance-mode: disable
```

but you also see that

```
# diagnose npu np6 hbq-stats all
cpu_ 0:0
...
cpu_39:0
Total :0
```

This means the `gtp-enhance-mode` is actually set to `enable`.

If these combinations occur, just run the command below:

```
config system npu
   set gtp-enhance-mode enable
   end
```

or

```
config system npu
   set gtp-enhance-mode disable
   end
```

Once this is done,reboot the device to let the 2 statuses match.

New features added in 5.6.1

GTP enhancement and GTP Performance Improvement. (423332)

The GTP changes in 5.6.1 take place in the following categories:

New GTP features and functionality enhancements.

- GTP message filter enhancements, including:
  - Unknown message white list
  - GTPv1 and GTPv2 profile separation
  - Message adoption.
- GTP IE white list.
- Global APN rate limit, including:
  - sending back REJECT message with back-off timer
  - "APN congestion" cause value
- GTP half-open, half-close configurable timer.

GTP performance improvements.

- Implemented RCU on GTP-U running path. i.e, no locking needed to look up tunnel state when processing GTP-U.

  Note the RCU is only applied on GTPv1 and GTPv2 tunnels. It is not used for GTPv0 tunnels, due to the fact that (1) GTPv0 traffic is relatively minor compared with GTPv1 and GTPv2, and (2) GTPv0 tunnel indexing is totally different from GTPv1 and GTPv2. GTPv0 tunnel is indexed by [IMSI, NSAPI]. GTPv1 and GTPv2 tunnel is indexed by [IP, TEID]
- Localized CPU memory usage on GTP-U running path.
- GTP-C: changed some GTP tables from RB tree to hash table, including
  - GTP request tables, and GTPv0 tunnel tables.
  - Testing showed, when handling millions of entries adding/deleting, hash table performance was much better.
  - 2.3.2 Hash table is compatible with RCU API, so we can apply RCU on these GTP-C tables later for further performance improvements.
- GTP-C, improved GTP path management logic, so that GTP path will time out sooner when there are no tunnels linked to it

CLI Changes:

New Diagnose commands:

```
diagnose firewall gtp
```

Option	Description
hash-stat-tunnel	GTP tunnel hash statistics.
hash-stat-v0tunnel	GTPv0 tunnel hash statistics.
hash-stat-path	GTP path hash statistics.
hash-stat-req	GTP request hash statistics.
vd-apn-shaper	APN shaper on VDOM level.
ie-white-list-v0v1	IE white list for GTPv0 or v1.
ie-white-list-v2	IE white list for GTPv2.

```
diagnose firewall gtp vd-apn-shaper
```

Option	Description
list	List

```
diagnose firewall gtp ie-white-list-v0v1
```

Option	Description
list	List

```
diagnose firewall gtp ie-white-list-v2
```

Option	Description
list	List

```
config gtp apn-shaperapn-shaper
```

Option	Description
`apn`	APN to match. Leave empty to match ANY. "apn" field can be empty, it matches ANY apn. when configured, it is used to set a limit for any apn which is not explicitly listed; Also, if configured, such an entry should be the last entry, as it is first-match rule.
`rate-limit`	Rate limit in packets/s (0 - 1000000, 0 means unlimited).
`action`	Action. [drop | reject] There is no back-off timer in GTPv0, therefor the `reject` action is not available for V0
`back-off-time`	Back off time in seconds (10 - 360). `back-off-time` visible when action is "reject"

Changed commands:

Under command `firewall gtp`, `config message-filter` is replaced by `set message-filter-v0v1`

Example:

```
config firewall gtp
   edit <name>
      set message-filter-v0v1
```

New fields have been added to the `config firewall gtp` command context

Option	Description
`half-open-timeout`	Half-open tunnel timeout (in seconds).
half-close-timeout	Half-close tunnel timeout (in seconds).

Example:

```
config firewall gtp
   edit <name>
      set half-open-timeout 10
      set half-close-timeout 10
```

Models affected by change

- FortiGate 3700D
- FortiGate 3700DX
- FortiGate 3800D

Overview of FortiOS Carrier features

FortiOS Carrier specific features include Multimedia messaging service (MMS) protection, and GPRS Tunneling Protocol (GTP) protection.

All FortiGate units, carrier-enabled or not, are capable of handling Stream Control Transmission Protocol (SCTP) traffic, which is a protocol designed for and primarily used in Carrier networks.

This section includes:

Overview

FortiOS Carrier provides all the features found on FortiGate units plus added features specific to carrier networks: MMS and GTP.

MMS

MMS is a standard for sending messages that include multimedia content between mobile phones. MMS is also popular as a method of delivering news and entertainment content including videos, pictures, and text. Carrier networks include four different MMS types of messages — MM1, MM3, MM4, and MM7.

GTP

The GPRS Tunneling Protocol (GTP) runs on GPRS carrier networks. GPRS is a GSM packet radio standard. It provides more efficient usage of the radio interface so that mobile devices can share the same radio channel. FortiOS supports GTPv1 and GTPv2.

GPRS provides direct connections to the Internet (TCP/IP) and X.25 networks for point-to-point services (connection-less/connection oriented) and point-to-multipoint services (broadcast).

GPRS currently supports data rates from 9.6 kbps to more than 100 kbps, and it is best suited for burst forms of traffic. GPRS involves both radio and wired components. The mobile phone sends the message to a base station unit (radio based) that converts the message from radio to wired, and sends the message to the carrier network and eventually the Internet (wired carrier network). See GTP.

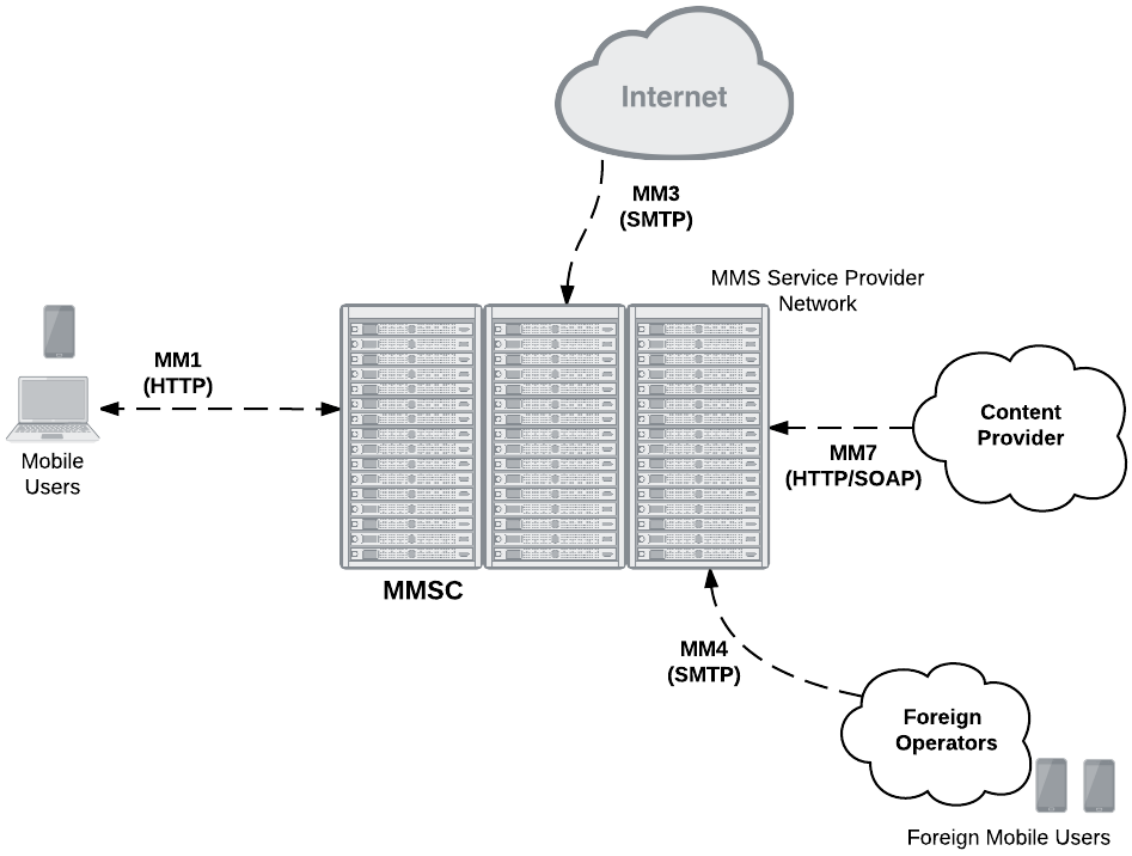
MMS Concepts

MMS background

MMS is a common method for mobile users to send and receive multimedia content. A Carrier network supports MMS across its network. This makes up the MMS Service Provider Network (MSPN).

Messages can be sent or received between the MMSC and a number of other services including the Internet, content providers, or other carriers. Each of these different service connections uses different MMS formats including MM1 and MM7 messages (essentially HTTP format), and MM3 and MM4 messages (SMTP formatted). These different formats reflect the different purposes and content for each type of MMS message.

MMS content interfaces



MMS content interfaces

MMS messages are sent from devices and servers to other devices and servers using MMS content interfaces

There are eight interfaces defined for the MMS standard, referred to as MM1 through MM8. The most important of these interfaces for the transfer of data is the MM1 interface, as this defines how mobile users communicate from the mobile network to the Multimedia Message Service Center (MMSC). MMS content to be monitored and controlled comes from these mobile users and is going to the provider network.

Other MMS content interfaces that connect a service provider network to other external sources can pose threats as well. MM3 handles communication between the Internet and the MMSC and is a possible source of viruses and other content problems from the Internet. MM4 handles communication between different content provider MMSCs. Filtering MM4 content protects the service provider network from content sent from foreign service providers and their subscribers. Finally MM7 is used for communication between content providers and the MMSC. Filtering MM3 content can also keep harmful content off of the service provider network.

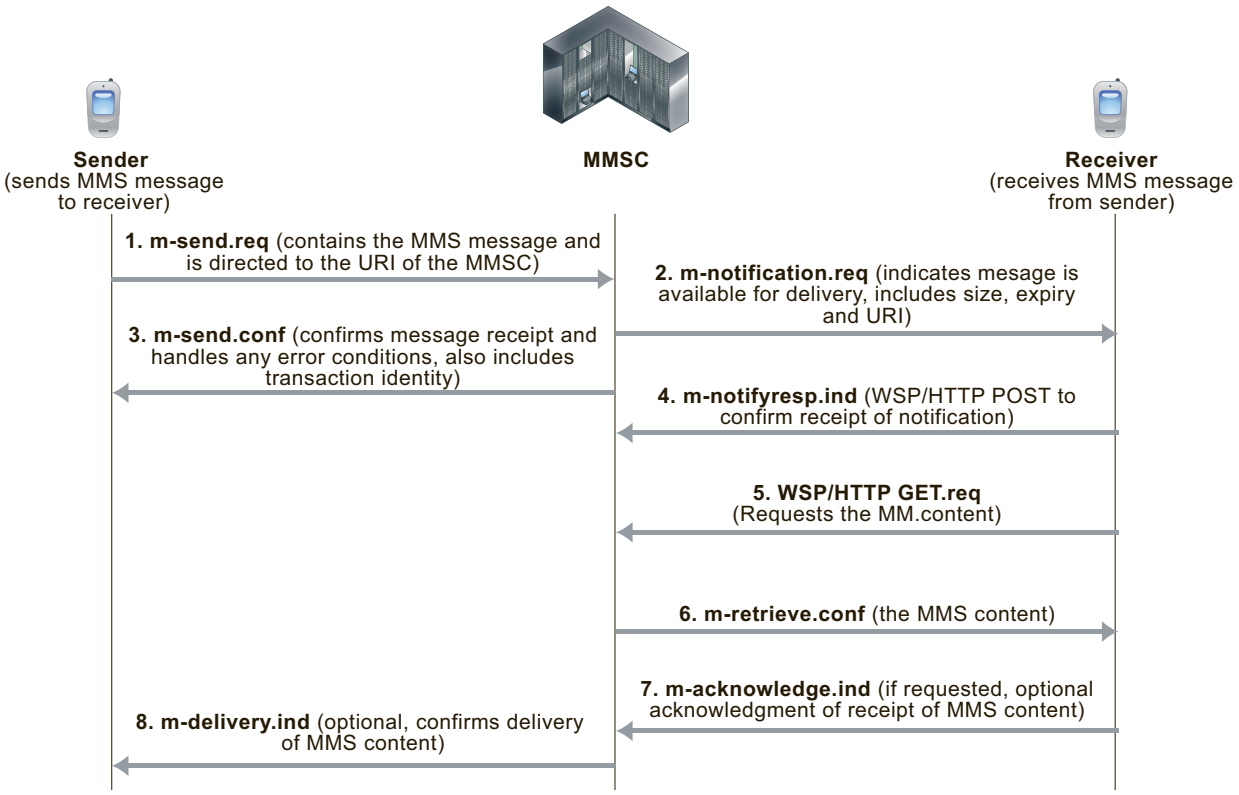
MMS content interfaces

Type	Transaction	Similar to
MM 1	Handset to MMSC	HTTP
MM 3	Between MMSC and Internet	SMTP
MM 4	Between Operator MMSCs	SMTP
MM 7	Content Providers to MMSC	HTTP and SOAP

How MMS content interfaces are applied

As shown below, the sender's mobile device encodes the MMS content in a form similar to MIME email message (MMS MIME content formats are defined by the MMS Message Encapsulation specification). The encoded message is then forwarded to the service provider's MMSC. Communication between the sending device and the MMSC uses the MM1 content interface. The MM1 content interface establishes a connection and sends an MM1 send request (`m-send.req`) message that contains the MMS message. The MMSC processes this request and sends back an MM1 send confirmation (`m-send.conf`) HTTP response indicating the status of the message — accepted or an error occurred, for example.

MM1 transactions between senders and receivers and the MMSC

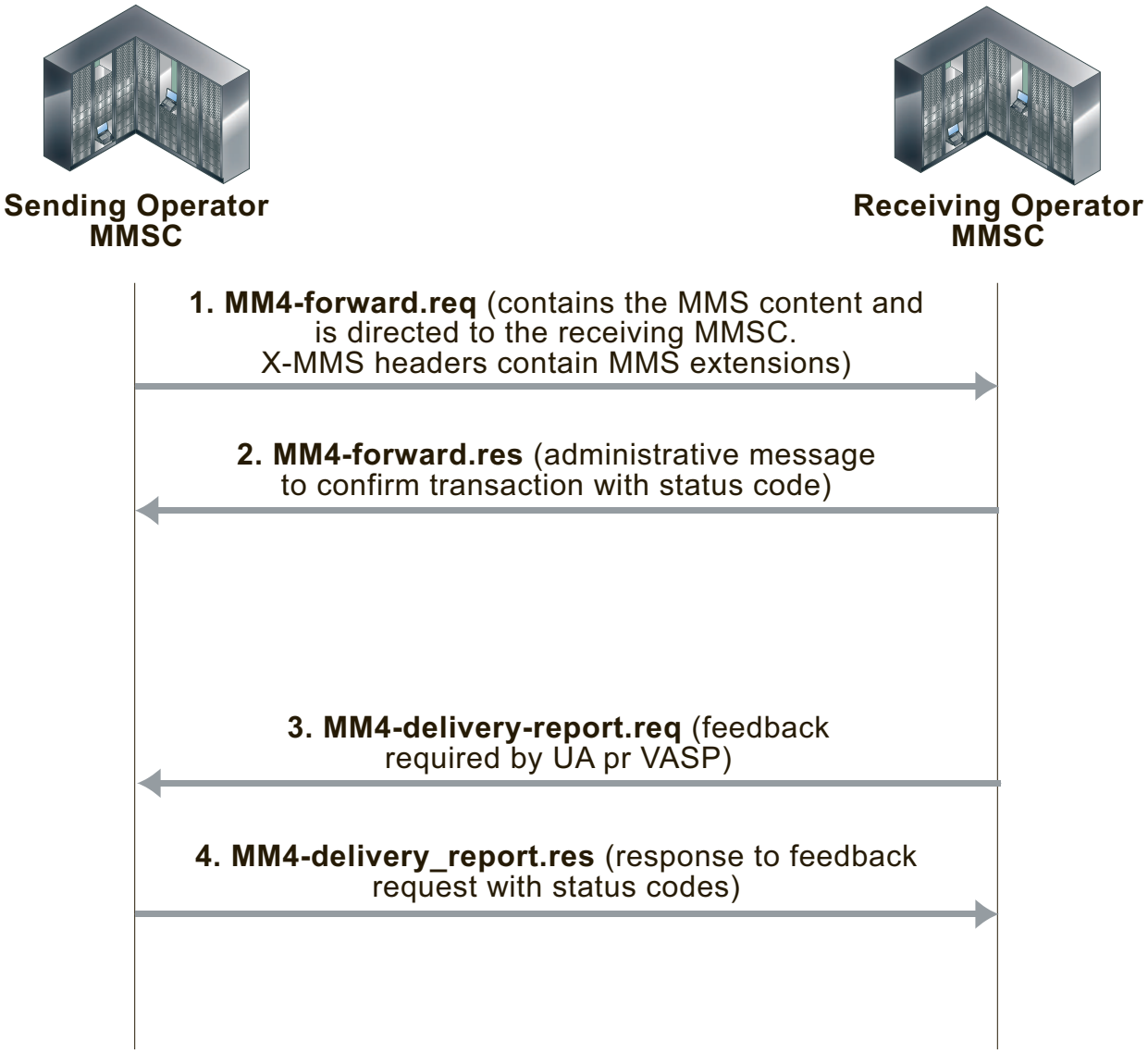


If the recipient is on another carrier, the MMSC forwards the message to the recipient's carrier. This forwarding uses the MM4 content interface for forwarding content between operator MMSCs (see the figure below).

Before the MMSC can forward the message to the final recipient, it must first determine if the receiver's handset can receive MMS messages using the MM1 content interface. If the recipient can use the MM1 content interface, the content is extracted and sent to a temporary storage server with an HTTP front-end.

To retrieve the message, the receiver's handset establishes a connection with the MMSC. An HTTP get request is then sent from the recipient to the MMSC. This message contains the URL where the content of the message is stored. The MMSC responds with a retrieve confirmation (`m-retrieve.conf`) HTTP response that contains the message.

MM4 messages sent between operator MMSCs



This causes the receiver's handset to retrieve the content from the embedded URL. Several messages are exchanged to indicate status of the delivery attempt. Before delivering content, some MMSCs also include a content adaptation service that attempts to modify the multimedia content into a format suitable for the recipient's handset.

If the receiver's handset is not MM1 capable, the message can be delivered to a web based service and the receiver can view the content from a normal Internet browser. The URL for the content can be sent to the receiver in an SMS text message. Using this method, non-MM1 capable recipients can still receive MMS content.

The method for determining whether a handset is MMS capable is not specified by the standards. A database is usually maintained by the operator, and in it each mobile phone number is marked as being associated with a legacy handset or not. It can be a bit hit and miss since customers can change their handset at will and this database is not usually updated dynamically.

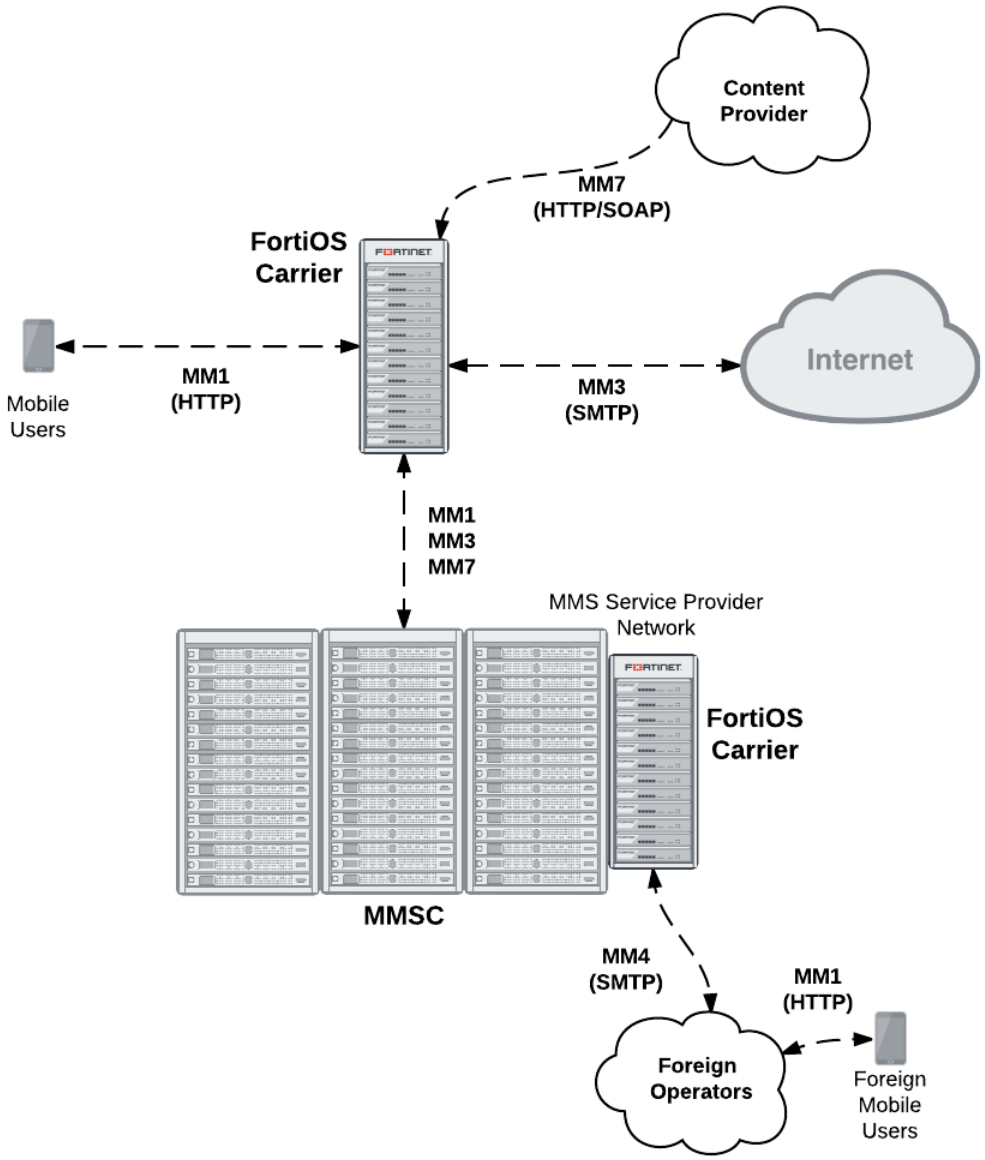
Email and web-based gateways from MMSC to the Internet use the MM3 content interface. On the receiving side, the content servers can typically receive service requests both from WAP and normal HTTP browsers, so

delivery via the web is simple. For sending from external sources to handsets, most carriers allow MIME encoded message to be sent to the receiver's phone number with a special domain.

How FortiOS Carrier processes MMS messages

MMS messages can be vectors for propagating undesirable content such as spam and viruses. FortiOS Carrier can scan MMS messages sent using the MM1, MM3, MM4, and MM7 content interfaces. You can configure FortiOS Carrier to scan MMS messages for spam and viruses by configuring and adding MMS protection profiles and adding the MMS protection profiles to security policies. You can also use MMS protection profiles to apply content blocking, carrier endpoint filtering, MMS address translation, sending MMS notifications, DLP archiving of MMS messages, and logging of MMS message activity.

FortiOS Carrier MMS processing



FortiOS Carrier can send MMS messages to senders informing those senders that their devices are infected. FortiOS Carrier can also send MMS notifications to administrators to inform them of suspicious activity on their networks.

For message floods and duplicate messages, FortiOS Carrier does not send notifications to message senders but does send notifications to administrators and sends messages to sender handsets to complete MM1 and MM4 sessions.

Where MMS messaging uses the TCP/IP set of protocols, SMS text messaging uses the Signaling System Number 7 (SS7) set of protocols, which is not supported by FortiOS.

FortiOS Carrier and MMS content scanning

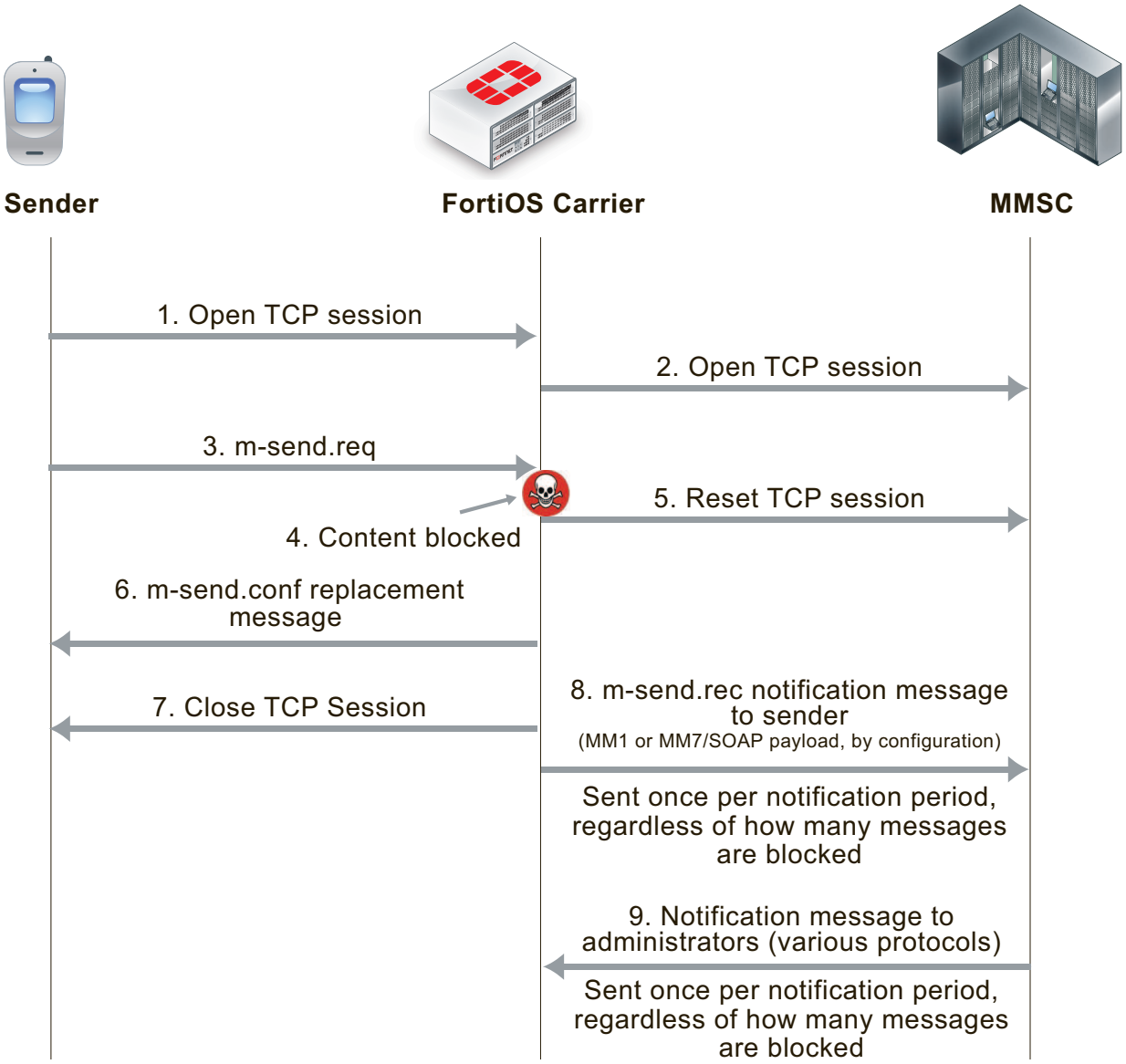
The following section applies to MMS content scanning, including virus scanning, file filtering, content spam filtering, carrier endpoint filtering, and MMS content checksum filtering.

MM1 Content Scanning

During MM1 content scanning a message is first transmitted from the sender, establishing a connection with the MMSC. FortiOS Carrier intercepts this connection and acts as the endpoint. FortiOS Carrier then establishes its own connection to the MMSC. Once connected, the client transmits its `m-send.req` HTTP post request to FortiOS Carrier which scans it according to the MMS protection profile settings. If the content is clean, the message is forwarded to the MMSC. The MMSC returns `m-send.conf` HTTP response through FortiOS Carrier to the sender.

If FortiOS Carrier blocks the message (for example because a virus was found, see the figure below), FortiOS Carrier resets the connection to the MMSC and sends `m-send.conf` HTTP response back to the sender. The response message can be customized using replacement messages. FortiOS Carrier then terminates the connection. Sending back an `m-send.conf` message prevents the sender from trying to send the message again.

MM1 MMS scanning of message sent by sender (blocking m.send.req messages)



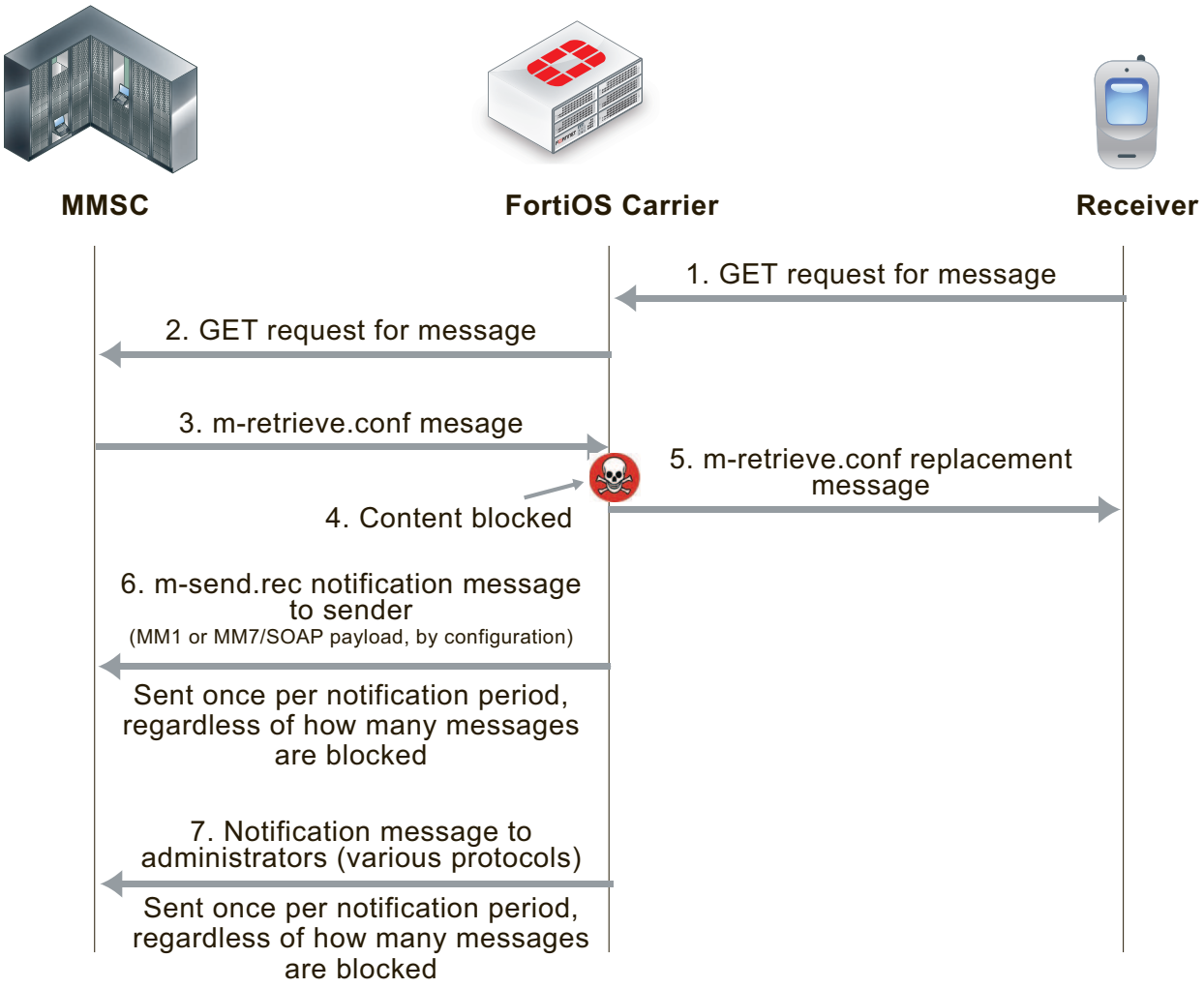
FortiOS Carrier also sends `m-send.rec` notifications messages to the MMSC that are then forwarded to the sender to notify them of blocked messages.

Filtering message retrieval

FortiOS Carrier intercepts the connection to the MMSC, and the m-retrieve.conf HTTP response from the MMSC is scanned according to the MMS content scanning settings. If the content is clean, the response is forwarded back to the client. If the content is blocked, FortiOS Carrier drops the connection to the MMSC. It then builds an m-retrieve.conf message from the associated replacement message and transmits this back to the client.

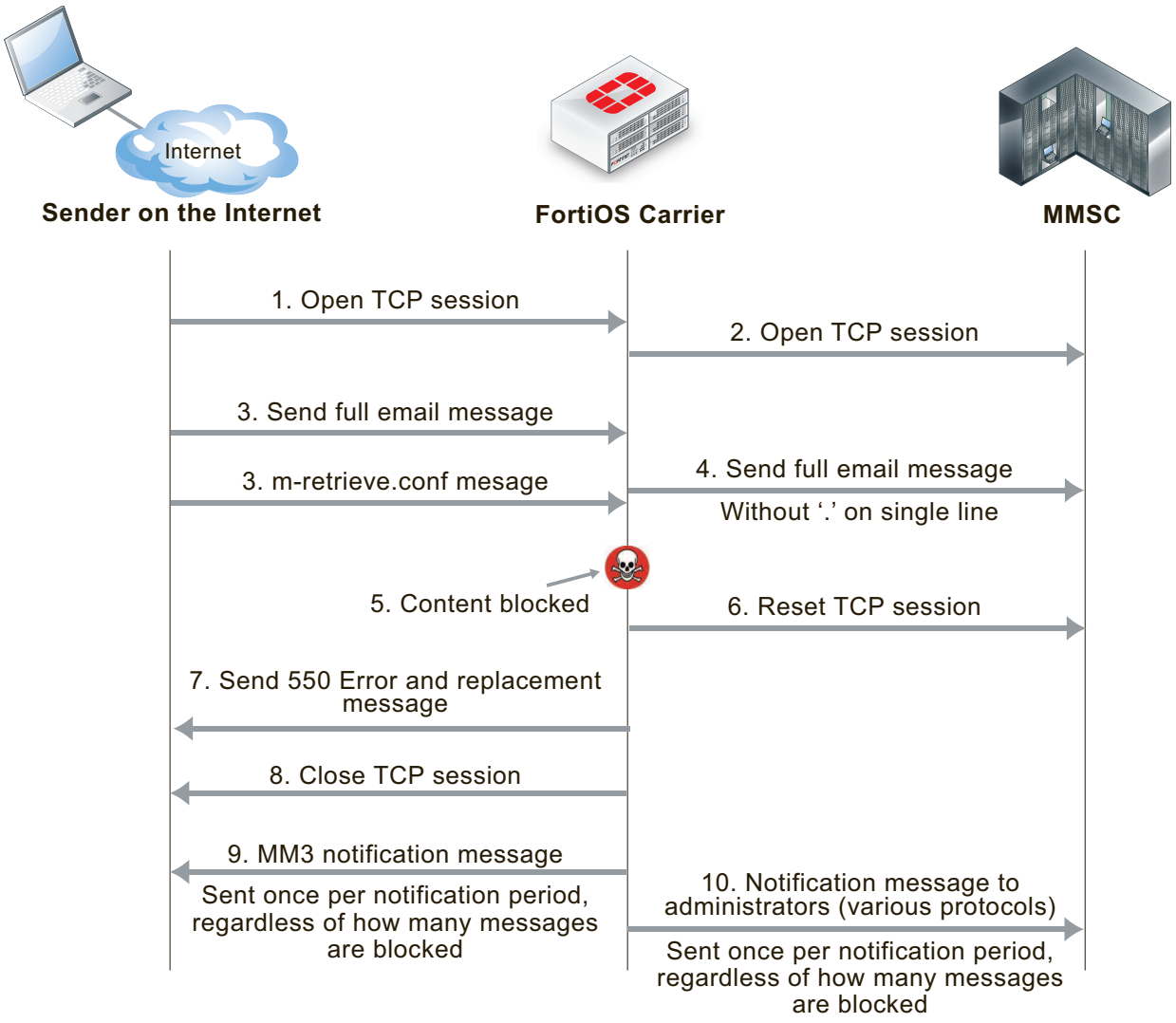
FortiOS Carrier also sends `m-send.rec` notifications messages to the MMSC that are then forwarded to the receiver to notify them of blocked messages.

MM1 MMS scanning of messages received by receiver (blocking m.retrieve.conf messages)

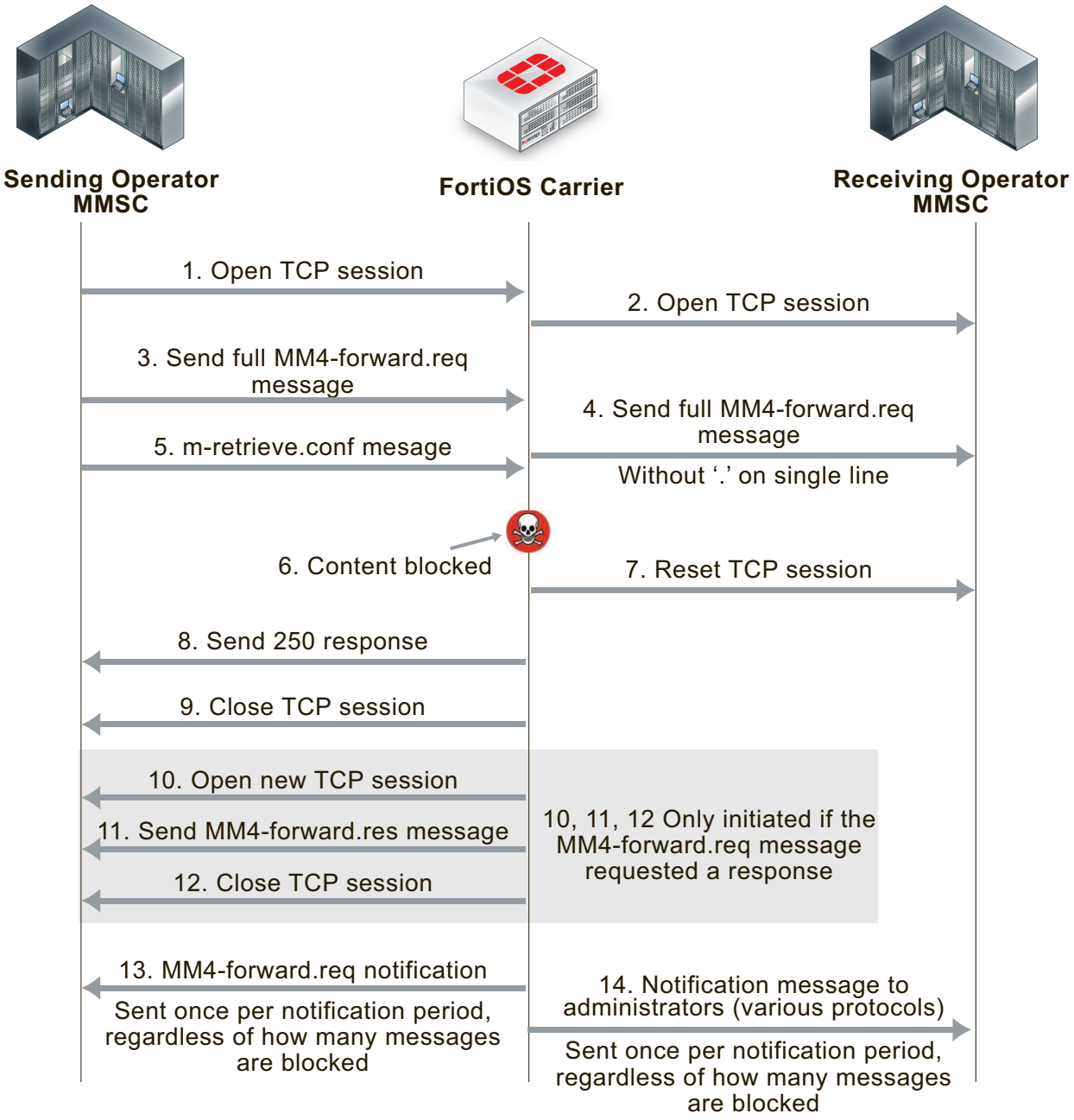


Filtering MM3 and MM4 messages works in an similar way to MM1 (see the figures below). FortiOS Carrier intercepts connections to the MMSC, and scans messages as configured. When messages are blocked, FortiOS Carrier closes sessions as required, sends confirmation messages to the sender, notifies administrators, and notifies senders and receivers of messages.

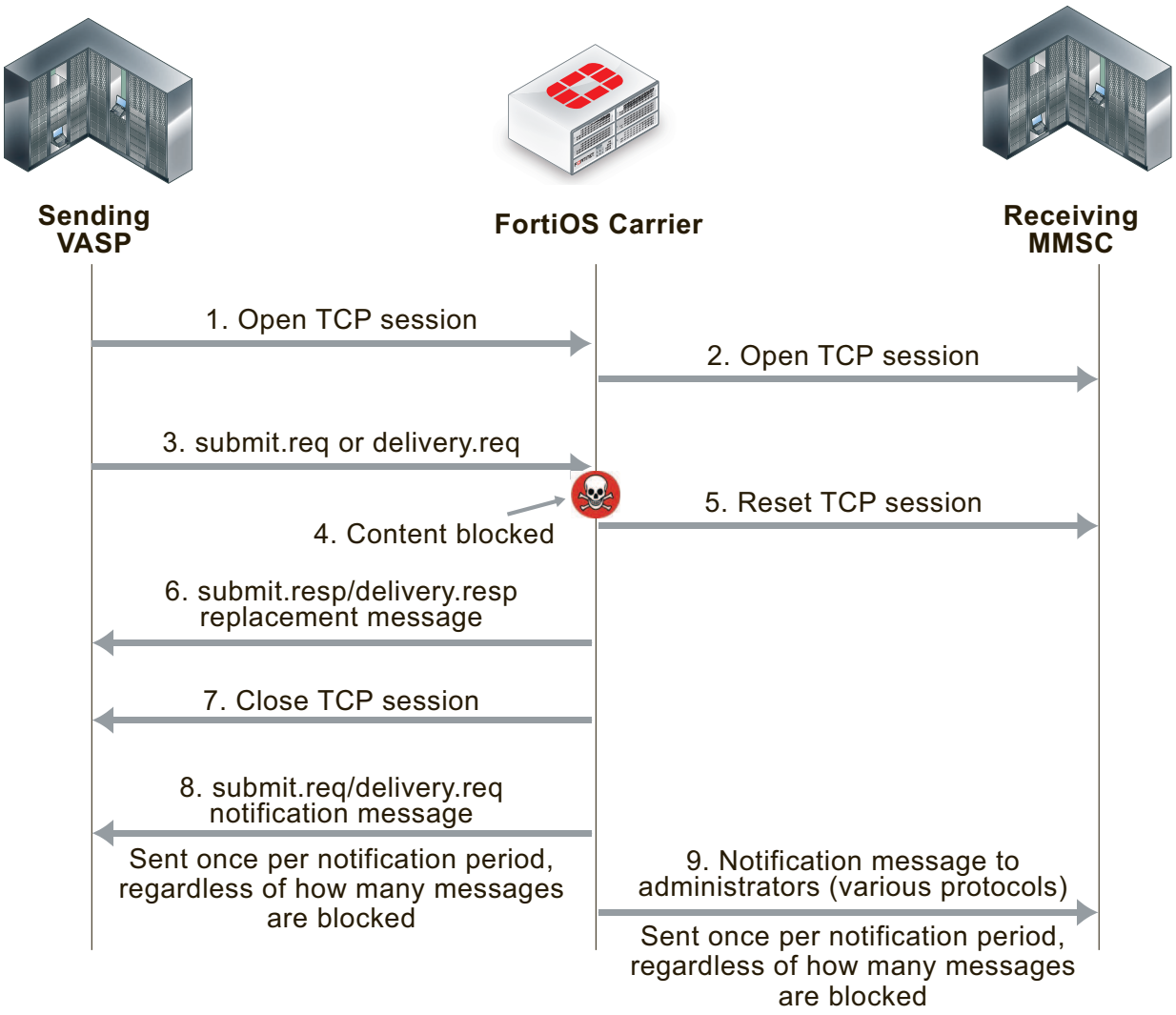
MM3 MMS scanning of messages sent from a sender on the Internet to an MMSC



MM4 MMS scanning of messages sent between operator MMSCs



MM7 MMS scanning of messages sent between a VASP and an MMSC



FortiOS Carrier and MMS duplicate messages and message floods

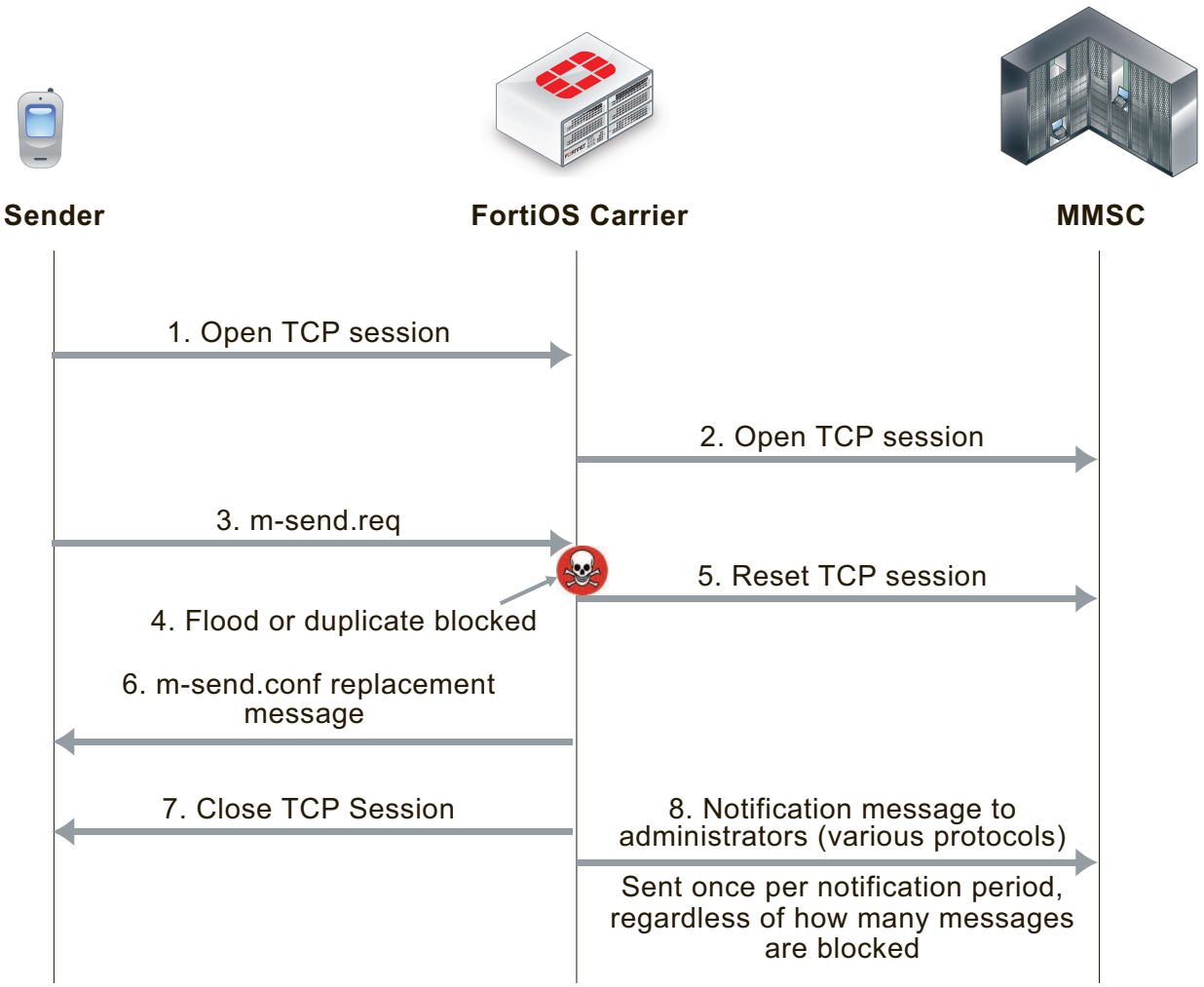
FortiOS Carrier detects duplicate messages and message floods for the MM1 and MM4 interfaces. How FortiOS Carrier detects and responds to duplicate messages and message floods is different from how FortiOS Carrier detects and responds to viruses and other MMS scanning protection measures.

For message floods and duplicate messages, the sender does not receive notifications about floods or duplicate messages, as if the sender is an attacker they can gain useful information about flood and duplicate thresholds. Plus, duplicate messages and message floods are usually a result of a large amount of messaging activity and filtering of these messages is designed to reduce the amount of unwanted messaging traffic. Adding to the traffic by sending notifications to senders and receivers could result in an increase in message traffic.

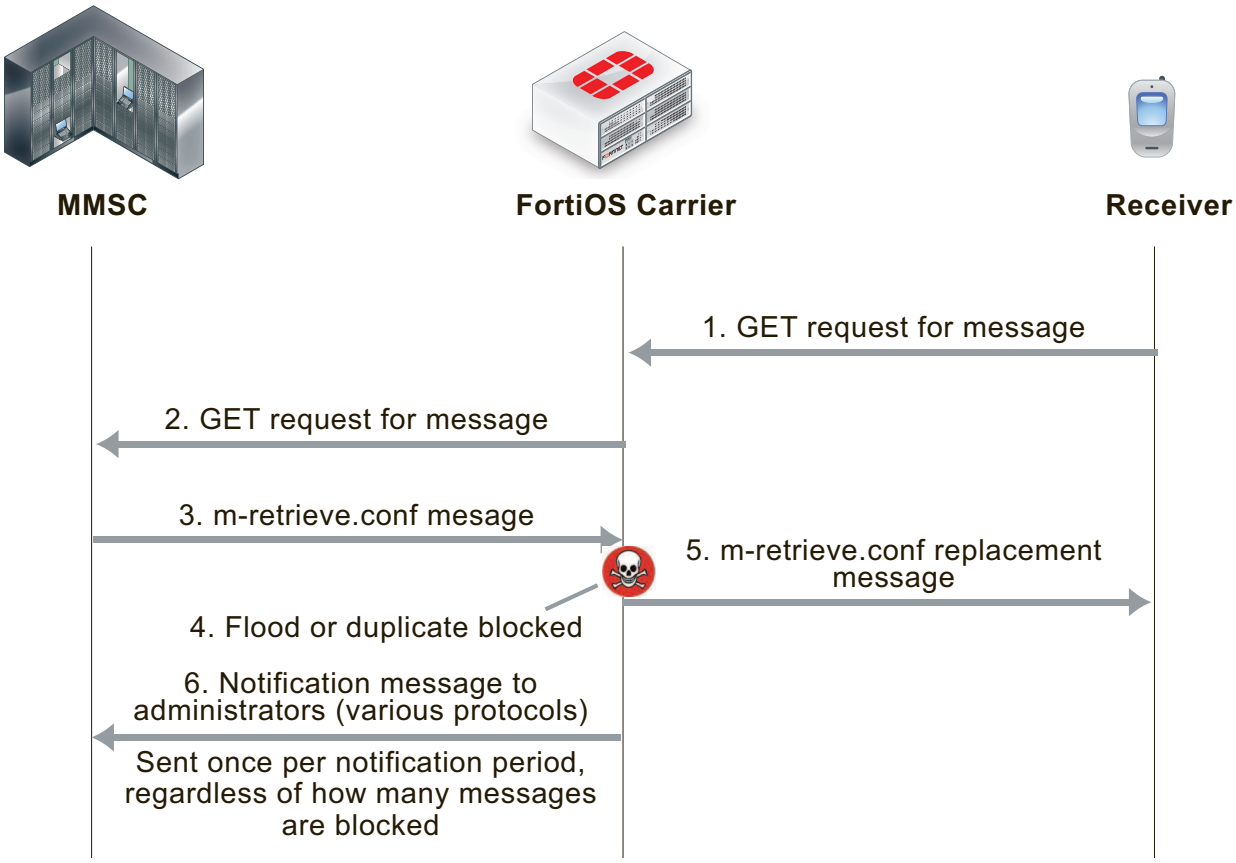
You can create up to three thresholds for detecting duplicate messages and message floods. For each threshold you can configure the FortiOS Carrier unit to respond by logging the activity, archiving or quarantining the messages, notifying administrators of the activity, and by blocking the messages. In many cases you may only want to configure blocking for higher activity thresholds, and to just monitor and send administrator notifications at lower activity thresholds.

When a block threshold is reached for MM1 messages, FortiOS Carrier sends m-send.conf or m-retrieve.conf messages to the originator of the activity. These messages are sent to end the MM1 sessions, otherwise the originator would continue to re-send the blocked message. When a block threshold is reached for MM4, FortiOS Carrier sends a `MM4-forward.res` message to close the MM4 session. An MM4 message is sent only if initiated by the originating `MM4-forward.req` message.

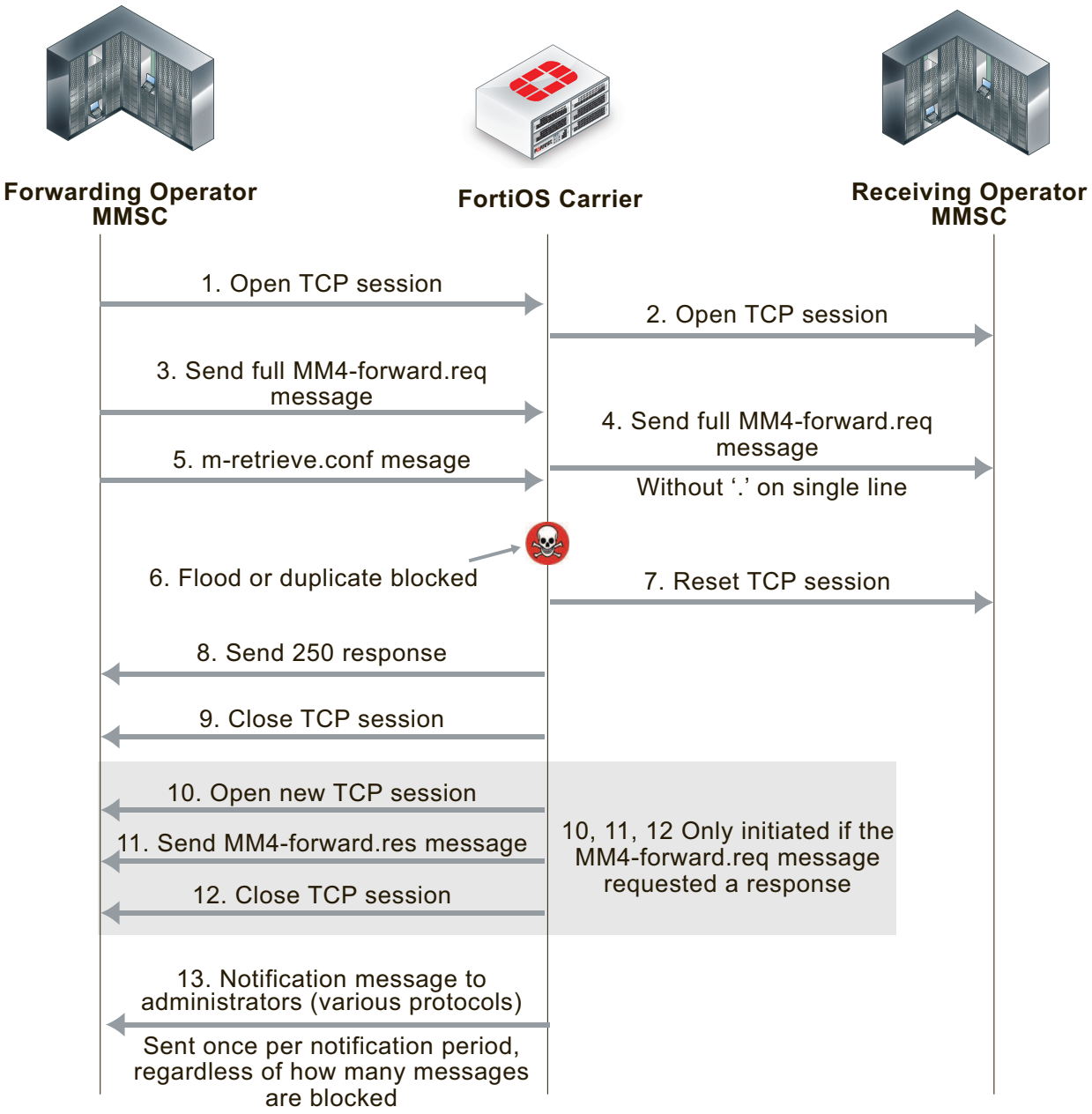
MM1 message flood and duplicate message blocking of sent messages



MM1 message flood and duplicate message blocking of received messages



MM4 message flood and duplicate message blocking



MMS protection profiles

An MMS protection profile is a group of settings that you can apply to an MMS session matched by a security policy.

MMS protection profiles are easy to configure and can be used by more than one security policy. You can configure a single MMS protection profile for the different traffic types handled by a set of security policies that require identical protection levels and types. This eliminates the need to repeatedly configure those same MMS protection profile settings for each individual security policy.

For example, while traffic between trusted and untrusted networks might need strict protection, traffic between trusted internal addresses might need only moderate protection. You would configure two separate MMS protection profiles to provide the different levels of protection: one for traffic between trusted networks, and one for traffic between trusted and untrusted networks.

Once you have configured the MMS Protection Profile, you need to add it to a security policy to apply the profile to MMS traffic.

Bypassing MMS protection profile filtering based on carrier endpoints

You can use carrier endpoint filtering to exempt MMS sessions from MMS protection profile filtering. Carrier endpoint filtering matches carrier endpoints in MMS sessions with carrier endpoint patterns. If you add a carrier endpoint pattern to a filter list and set the action to exempt from all scanning, all messages from matching carrier endpoints bypass MMS protection profile filtering. See Bypassing message flood protection based on user's carrier endpoints.

Applying MMS protection profiles to MMS traffic

To apply an MMS protection profile you must first create the MMS protection profile and then add the MMS protection profile to a security policy by enabling the Carrier security profile. The MMS protection profile then applies itself to the traffic accepted by that security policy.

MMS protection profiles can contain settings relevant to many different services. Each security policy uses the subset of the MMS protection profile settings that apply to the sessions accepted by the security policy. In this way, you might define just one MMS protection profile that can be used by many security policies, each policy using a different or overlapping subset of the MMS protection profile.

To add an MMS protection profile to a security policy

1. Go to **Security Profiles > MMS Profile**.
2. Select **Create New** to add an MMS protection profile.
3. Configure as needed, and save.
4. Go to **Policy & Objects > IPv4 Policy**.
5. Select **Create New** to add a security policy, or select an existing policy and **Edit** to add the MMS profile.
6. Configure the security policy as required.
7. Enable **MMS Profile**, and select the MMS profile to add to the security policy.
8. Select **OK**.

MMS Configuration

MMS profiles

Since MMS profiles can be used by more than one security policy, you can configure one profile for the traffic types handled by a set of security policies requiring identical protection levels and types, rather than repeatedly configuring those same profile settings for each individual security policy.

If the security policy requires authentication, do not select the MMS profile in the security policy. This type of profile is specific to the authenticating user group. For details on configuring the profile associated with the user group, see User Groups in the Authentication guide.

For example, while traffic between trusted and untrusted networks might need strict protection, traffic between trusted internal addresses might need moderate protection. To provide the different levels of protection, you might configure two separate protection profiles: one for traffic between trusted networks, and one for traffic between trusted and untrusted networks.

Once you have configured the MMS profile, you can then apply the profile to MMS traffic by applying it to a security policy.

MMS profiles can contain settings relevant to many different services. Each security policy uses the subset of the MMS profile settings that apply to the sessions accepted by the security policy. In this way, you might define just one MMS profile that can be used by many security policies, each policy using a different or overlapping subset of the MMS profile.

The MMS Profile page contains options for each of the following:

- MMS scanning
- MMS Bulk Email Filtering Detection
- MMS Address Translation
- MMS Notifications
- DLP Archive
- Logging

MMS profile configuration settings

The following are MMS profile configuration settings in **Security Profiles > MMS Profile**.

MMS Profile page Lists each individual MMS profile that you created. On this page, you can edit, delete or create an MMS profile.	
Create New	Creates a new MMS profile. When you select **Create New**, you are automatically redirected to the New MMS Profile page.
Edit	Modifies settings within an MMS profile. When you select **Edit**, you are automatically redirected to the Edit MMS Profile.
Delete	Removes an MMS profile from the list on the MMS Profile page. To remove multiple MMS profiles from within the list, on the MMS Profile page, in each of the rows of the profiles you want removed, select the check box and then select **Delete**. To remove all MMS profiles from the list, on the MMS Profile page, select the check box in the check box column, and then select **Delete**.
Name	The name of the MMS profile.

Ref.	Displays the number of times the object is referenced to other objects. For example, av_1 profile is applied to a security policy; on the Profile page (**Security Profiles > Antivirus**), 1 appears in **Ref.** . To view the location of the referenced object, select the number in **Ref.**, and the Object Usage window appears displaying the various locations of the referenced object. To view more information about how the object is being used, use one of the following icons that is avialable within the Object Usage window: **View the list page for these objects** – automatically redirects you to the list page where the object is referenced at. **Edit this object** – modifies settings within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy and so, when this icon is selected, the user is redirected to the Edit Policy page. **View the details for this object** – table, similar to the log viewer table, contains information about what settings are configured within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy, and that security policy's settings appear within the table.
New MMS Profile page Provides settings for configuring an MMS profile. This page also provides settings for configuring DLP archives and logging.	
Profile Name	Enter a name for the profile.
Comments	Enter a description about the profile. This is optional.
MMS Scanning	Configure MMS Scanning options.
MMS Bulk Email Filtering Detection	Configure MMS Bulk Email options.
MMS Address Translation	Configure MMS Address Translation options.
MMS Notifications	Configure MMS Notification options.
DLP Archive	Configure DLP archive option.
Logging	Configure logging options.

MMS scanning options

You can configure MMS scanning protection profile options to apply virus scanning, file filtering, content filtering, carrier endpoint blocking, and other scanning to MMS messages transmitted using the MM1, MM3, MM4 and

MM7 protocols.

The following are the MMS Scanning options that are available within an MMS profile. You can create an MMS profile in **Security Profiles > MMS Profile** or edit an existing one. You must expand MMS Scanning to access the following options.

MMS Scanning section of the New MMS Profile page	
Monitor Only	Select to cause the unit to record log messages when MMS scanning options find a virus, match a file name, or match content using any of the other MMS scanning options. Select this option to be able to report on viruses and other problems in MMS traffic without affecting users. **Tip:** Select **Remove Blocked** if you want the unit to actually remove content intercepted by MMS scanning options.
Virus Scan	Select to scan attachments in MMS traffic for viruses. Since MM1 and MM7 use HTTP, the oversize limits for HTTP and the HTTP antivirus port configuration also applies to MM1 and MM7 scanning. MM3 and MM4 use SMTP and the oversize limits for SMTP and the SMTP antivirus port configuration also applies to MM3 and MM4 scanning.
Scan MM1 message retrieval	Select to scan message retrievals that use MM1. If you enable **Virus Scan** for all MMS interfaces, messages are also scanned while being sent. In this case, you can disable MM1 message retrieval scanning to improve performance.
Remove Blocked	Select to remove blocked content from each protocol and replace it with the replacement message. Select **Constant** if the unit is to preserve the length of the message when removing blocked content, as may occur when billing is affected by the length of the message. **Tip:** If you only want to monitor blocked content, select **Monitor Only**.
Content Filter	Select to filter messages based on matching the content of the message with the words or patterns in the selected web content filter list. For information about adding a web content filter list, see the FortiGate CLI Reference.
Carrier Endpoint Block	Select to add **Carrier Endpoint Filtering** in this MMS profile. Select the carrier endpoint filter list to apply it to the profile.

MMS Scanning section of the New MMS Profile page	
MMS Content Checksum	Select to add MMS Content Checksum in this MMS profile. Select the MMS content checksum list to apply it to the profile.
Pass Fragmented Messages	Select to pass fragmented MM3 and MM4 messages. Fragmented MMS messages cannot be scanned for viruses. If you do not select these options, fragmented MM3 and MM4 message are blocked.
Comfort Clients	Select client comforting for MM1 and MM7 sessions. Since MM1 and MM7 messages use HTTP, MM1 and MM7 client comforting operates like HTTP client comforting.
Comfort Servers	Select server comforting for each protocol. Similar to client comforting, you can use server comforting to prevent server connection timeouts that can occur while waiting for the unit to buffer and scan large POST requests from slow clients.
Interval (1-900 seconds)	Enter the time in seconds before client and server comforting starts after the download has begun, and the time between sending subsequent data.
Amount (1-10240 bytes)	The number of bytes sent by client or server comforting at each interval.
Oversized MMS Message	Select **Block** or **Pass** for files and email messages exceeding configured thresholds for each protocol. The oversize threshold refers to the final size of the message, including attachments, after encoding by the client. Clients can use a variety of encoding types; some result in larger file sizes than the original attachment. As a result, a file may be blocked or logged as oversized even if the attachment is several megabytes smaller than the oversize threshold.
Threshold (1KB - 800 MB)	Enter the oversized file threshold and select KB or MB. If a file is larger than the threshold the file is passed or blocked depending on the ***Oversized MMS Message*** setting. The web-based manager displays the allowed threshold range. The threshold maximum is 10% of the unit's RAM.

MMS Bulk Anti-Spam Detection options

You can use the MMS bulk email filtering options to detect and filter MM1 and MM4 message floods and duplicate messages. You can configure three thresholds that define a flood of message activity and three thresholds that define excessive duplicate messages. The configuration of each threshold includes the response actions for the threshold.

The configurable thresholds for each of the flood and duplicate sensors and must be enabled in sequence. For example, you can enable Flood Threshold 1 and Flood Threshold 2, but you cannot disable Flood Threshold 1 and enable Flood Threshold 2.

You can also add MSISDN to the bulk email filtering configuration and select a subset of the bulk email filtering options to applied to these individual MSISDNs.

You must first select MM1 and/or MM4 to detect excessive message duplicates. If excessive message duplicates are detected, the unit will perform the **Duplicate Message Action** for the specified duration.

You can configure three duplicate message thresholds and enable them with separate values and actions. They are labeled Duplicate Threshold 1 through 3 and must be enabled in sequence. For example, you can enable Duplicate Threshold 1 and Duplicate Threshold 2, but you cannot disable Duplicate Threshold 1 and enable Duplicate Threshold 2.

When traffic accepted by a security policy that contains an MMS profile with duplicate message configured receives MM1 or MM4 duplicate messages that match a threshold configured in the MMS protection profile, the unit performs the duplicate message action configured for the matching threshold.

You can configure three message flood thresholds and enable them with separate values and actions. They are labeled Flood Threshold 1 through 3 and must be enabled in sequence. For example, you can enable Flood Threshold 1 and Flood Threshold 2, but you cannot disable Flood Threshold 1 and enable Flood Threshold 2.

When traffic accepted by a security policy that contains an MMS protection profile with message flooding configured experiences MM1 or MM4 message flooding that matches a threshold configured in the MMS profile, the unit performs the message flood action configured for the matching threshold.

MMS Bulk Anti-Spam Detection

This section of the New MMS Profile page contains numerous sections where you can configure specific settings for flood threshold, duplicate threshold and recipient MSISDNs.

Message Flood

The message flood settings for each flood threshold. Expand each to configure settings for a threshold.

Flood Threshold 1	Expand to reveal the flood threshold settings for Flood Threshold 1. The settings for Flood Threshold 1 are the same for Flood Threshold 2 and 3.
Enable	Select to apply Flood Threshold 1 to the MSISDN exception.
Message Flood Window	Enter the period of time during which a message flood will be detected if the **Message Flood Limit** is exceeded. The message flood window can be 1 to 2880 minutes (48 hours).
Message Flood Limit	Enter the number of messages which signifies a message flood if exceeded within the **Message Flood Window**.
Message Flood Block Time	Enter the amount of time during which the unit performs the **Message Flood Action** after a message flood is detected.

Message Flood Action	Select one or more actions that the unit is to perform when a message flood is detected.
Flood Threshold 2	Expand to configure settings for Flood Threshold 2 or 3 respectively.
Flood Threshold 3	
Duplicate Message	
The duplicate message threshold settings. Expand each to configure settings for a threshold.	
MM1 Retrieve Duplicate Enable	Select to scan MM1 `mm1-retr` messages for duplicates. By default, `mm1-retr` messages are not scanned for duplicates as they may often be the same without necessarily being bulk or spam.
Enable	Select to enable the selected duplicate message threshold and to make the rest of the options available for configuration.
Duplicate Message Window	Enter the period of time during which excessive message duplicates will be detected if the Duplicate message Limit it exceeded. The duplicate message window can be 1 to 2880 minutes (48 hours).
Duplicate Message Limit	Enter the number of messages which signifies excessive message duplicates if exceeded within the Duplicate Message Window.
Duplicate Message Block Time	Enter the amount of time during which the unit will perform the Duplicate Message Action after a message flood is detected.
Duplicate Message Action	Select one or more actions that the unit is to perform when excessive message duplication is detected.
Duplicate Threshold 2	Expand to configure settings for Duplicate Threshold 2 or 3 respectively.
Duplicate Threshold 3	
Recipient MSISDN	
The recipient Mobile Subscriber Integrated Services Digital Network Number (MSISDN) settings for each recipient MSISDN. When you select **Create New**, you are automatically redirected to the New MSISDN page. You need to save the profile before you can add MSISDNs.	
Recipient MSISDN	The recipient MSISDN.
Flood Threshold 1	Check to enable Flood Threshold 1 settings for this MSISDN.
Flood Threshold 2	Check to enable Flood Threshold 2 settings for this MSISDN.
Flood Threshold 3	Check to enable Flood Threshold 3 settings for this MSISDN..

Duplicate Threshold 1	Check to enable Duplicate Threshold 1 settings for this MSISDN.
Duplicate Threshold 2	Check to enable Duplicate Threshold 2 settings for this MSISDN..
Duplicate Threshold 3	Check to enable Duplicate Threshold 3 settings for this MSISDN..
Edit	Modifies the settings of a Recipient MSISDN in the Recipient MSISDN list. When you select **Edit**, you are automatically redirected to the New MSISDN page.
Delete	Removes a Recipient MSISDN in the Recipient MSISDN list within the Recipient MSISDN section of the page.
New MSISDN page	
Create New	Creates a new Recipient MSISDN. When you select **Create New**, you are automatically redirected to the New MSISDN page.
Recipient MSISDN	Enter a name for the recipient MSISDN.
Flood Threshold 1	Select to apply Flood Threshold 1 to the MSISDN exception.
Flood Threshold 2	Select to apply Flood Threshold 2 to the MSISDN exception.
Flood Threshold 3	Select to apply Flood Threshold 3 to the MSISDN exception.
Duplicate Threshold 1	Select to apply Duplicate Threshold 1 to the MSISDN exception.
Duplicate Threshold 2	Select to apply Duplicate Threshold 2 to the MSISDN exception.
Duplicate Threshold 3	Select to apply Duplicate Threshold 3 to the MSISDN exception.

MMS Address Translation options

The sender’s carrier endpoint is used to provide logging and reporting details to the mobile operator and to identify the sender of infected content.

When MMS messages are transmitted, the **From** field may or may not contain the sender's address. When the address is not included, the sender information will not be present in the logs and the unit will not be able to notify the user if the message is blocked unless the sender's address is made available elsewhere in the request.

The unit can extract the sender's address from an extended HTTP header field in the HTTP request. This field must be added to the HTTP request before it is received by the unit. If this field is present, it will be used instead of the sender's address in the MMS message for logging and notification. If this header field is present when a message is retrieved, it will be used instead of the **To** address in the message. If this header field is not present the content of the **To** header field is used instead.

Alternatively, the unit can extract the sender’s address from a cookie.

You can configure MMS address translation to extract the sender’s carrier endpoint so that it can be added to log and notification messages. You can configure MMS address translation settings to extract carrier endpoints from

HTTP header fields or from cookies. You can also configure MMS address translation to add an endpoint prefix to the extracted carrier endpoints. For more information, see Dynamic Profiles and Endpoints in the Authentication guide.

MMS Address Translation	
Sender Address Source	Select to extract the sender's address from the **HTTP Header Field** or a **Cookie**. You must also specify the identifier that contains the carrier endpoint.

Sender Address Identifier	Enter the sender address identifier that includes the carrier endpoint. The default identifier is `x-up-calling-line-id`.
	
	If the **Sender Address Source** is **HTTP Header Field**, the address and its identifier in the HTTP request header takes the format:
	
	`<Sender Address Identifier>: <MSISDN_value>`
	
	Where the `<MSISDN_value>` is the carrier endpoint. For example, the HTTP header might contain:
	
	`x-up-calling-line-id: 6044301297`
	
	where `x-up-calling-line-id` would be the Sender Address Identifier.
	
	If the **Sender Address Source** is Cookie, the address and its identifier in the HTTP request header's `Cookie` field takes the format of attribute-value pairs:
	
	`Cookie: id=<cookie-id>;`
	
	`<Sender Address Identifier>=<MSISDN Value>`
	
	For example, the HTTP request headers might contain:
	
	`Cookie: id=0123jf!a;x-up-calling-line-id=6044301297`
	
	where `x-up-calling-line-id` would be the **Sender Address Identifier**.

Convert Sender Address From / To HEX	Select to convert the sender address from ASCII to hexadecimal or from hexadecimal to ASCII. This is required by some applications.
Add Carrier Endpoint Prefix for Logging / Notification	Select the following to enable adding endpoint prefixes for logging and notification.

MMS Address Translation	
Enable	Select to enable adding the country code to the extracted carrier endpoint, such as the MSISDN, for logging and notification purposes. You can limit the number length for the test numbers used for internal monitoring without a country code.
Prefix	Enter a carrier endpoint prefix to be added to all carrier endpoints. Use the prefix to add extra information to the carrier endpoint in the log entry.
Minimum Length	Enter the minimum length of the country code information being added. If this and Maximum Length are set to zero (`0`), length is not limited.
Maximum Length	Enter the maximum length of the country code information being added. If this and Minimum Length are set to zero (`0`), length is not limited.

MMS Notifications

MMS notifications are messages that a unit sends when an MMS profile matches content in an MM1, MM3, MM4 or MM7 session. For example, the MMS profile detects a virus or uses content blocking to block a web page, text message or email. You can send notifications to the sender of the message using same protocol and the addressing headers in the original message. You can also configure MMS notifications to send notification messages to another destination (such as a system administrator) using the MM1, MM3, MM4 or MM7 protocol.

You need to enable one or more **Notification Types** or you can add an **Antivirus Notification List** to enable sending notifications,.

You can also use MMS notifications options to configure how often notifications are sent. The unit sends notification messages immediately for the first event, then at a configurable interval if events continue to occur. If the interval does not coincide with the window of time during which notices may be sent, the unit waits to send the notice in the next available window. Subsequent notices contain a count of the number of events that have occurred since the previous notification.

There are separate notifications for each notification type, including virus events. Virus event notifications include the virus name. Up to three viruses are tracked for each user at a time. If a fourth virus is found, one of the existing tracked viruses is removed from the list.

The notifications are MM1 `m-send-req` messages sent from the unit directly to the MMSC for delivery to the client. The host name of the MMSC, the URL to which `m-send-req` messages are sent, and the port must be specified.

MMS Notification	
Antivirus Notification List	Optionally select an antivirus notification list to select a list of virus names to send notifications for. The unit sends a notification message whenever a virus name or prefix in the antivirus notification list matches the name of a virus detected in a session scanned by the MMS protection profile. Select **Disabled** if you do not want to use a notification list. Instead of selecting a notification list you can configure the **Virus ScanNotification Type** to send notifications for all viruses.
Message Protocol	In each column, select the protocol used to send notification messages. You can use a different protocol to send the notification message than the protocol on which the violation was sent. The MMS Notifications options change depending on the message protocol that you select. If you select a different message protocol, you must also enter the User Domain. If selecting MM7 you must also enter the Message Type.
Message Type	Select the MM7 message type to use if sending notifications using MM7. Options include deliver.REQ and submit.REQ
Detect Server Details	Select to use the information in the headers of the original message to set the address of the notification message. If you do not select this option, you can enter the required addressing information manually. You cannot select **Detect Server Details** if you are sending notification messages using a different message protocol. If you select **Detect Server Details**, you cannot change the **Port** where the notification is being sent.
Hostname	Enter the FQDN or the IP address of the server where the notifications will be sent.
URL	Enter the URL of the server. For example if the notificaiton is going to www.example.com/home/alerts , the URL is /home/alerts. This option is available only when **Message Protocol** is **mm1** or **mm7**.
Port	Enter the port number of the server. You cannot change the ***Port*** if ***Detect Server Details*** is enabled.

MMS Notification	
Username	Enter the user name required for sending messages using this server (optional). This option is available only when **Message Protocol** is **mm7**.
Password	Enter the password required for sending messages using this server (optional). This option is available only when **Message Protocol** is **mm7**.
VASP ID	Enter the value-added-service-provider (VASP) ID to be used when sending a notification message. If a VAS is not offered by the mobile provider, it is offered by a third party or a VAS provider or content provider (CP). This option is available only when **Message Protocol** is **mm7**.
VAS ID	Enter the value-added-service (VAS) ID to be used when sending a notification message. A VAS is generally any service beyond voice calls and fax. This option is available only when **Message Protocol** is **mm7**.
All Notification Types	In each column, select notification for all MMS event types for that MMS protocol, then enter the amount of time and select the time unit for notice intervals. Alternatively, expand **All Notification Types**, and then select notification for individual MMS event types for each MMS protocol. Then enter the amount of time and select the time unit for notice intervals. Not all event types are available for all MMS protocols.
Content Filter	In each column, select to notify when messages are blocked by the content filter, then enter the amount of time and select the time unit for notice intervals.
File Block	In each column, select to notify when messages are blocked by file block, then enter the amount of time and select the time unit for notice intervals.
Carrier Endpoint Block	In each column, select to notify when messages are blocked, then enter the amount of time and select the time unit for notice intervals.
Flood	In each column, select to notify when message flood events occur, then enter the amount of time and select the time unit for notice intervals.

MMS Notification	
Duplicate	In each column, select to notify when duplicate message events occur, then enter the amount of time and select the time unit for notice intervals.
MMS Content Checksum	In each column, select to notify when the content within an MMS message is scanned and banned because of the checksum value that was matched.
Virus Scan	In each column, select to notify when the content within an MMS message is scanned for viruses.
Notifications Per Second Limit	For each MMS protocol, enter the number of notifications to send per second. If you enter zero (0), the notification rate is not limited.
Day of Week	For each MMS protocol, select the days of the week the unit is allowed to send notifications.
Window Start Time	For each MMS protocol, select the time of day to begin the message alert window. By default, the message window starts at 00:00. You can change this if you want to start the message window later in the day. When configured, notification outside this window will not be sent.
Window Duration	For each MMS protocol, select the time of day at which to end the message alert window. By default, the message window ends at 00:24. You can change this if you want to end the message window earlier in the day. When configured, notification outside this window will not be sent

DLP Archive options

Select DLP archive options to archive MM1, MM3, MM4, and MM7 sessions. In addition to the MMS profile's DLP archive options, you can:

- Archive MM1 and MM7 message floods
- Archive MM1 and MM7 duplicate messages
- Select **DLP archiving** for carrier endpoint patterns in a **Carrier Endpoint List** and select the **Carrier Endpoint Block** option in the **MMS Scanning** section of an MMS Profile

The unit only allows one sixteenth of its memory for transferring content archive files. For example, for units with 128 MB RAM, only 8 MB of memory is used when transferring content archive files. Best practices dictate to not enable full content archiving if antivirus scanning is also configured because of these memory constraints.

DLP Archive	
Display DLP meta-information on the system dashboard	Select each required protocol to display the content archive summary in the Log and Archive Statistics dashboard widget on the System Dashboard.

DLP Archive	
Archive to FortiAnalyzer/FortiGuard	Select the type of archiving that you want for the protocol (MM1, MM3, MM4, and MM7). You can choose from Full, Summary or None. **None —** Do not send content archives. **Summary —** Send content archive metadata only. Includes information such as date and time, source and destination, request and response size, and scan result. **Full —** Send content archive both metadata and copies of files or messages. In some cases, FortiOS Carrier may not archive content, or may make only a partial content archive, regardless of your selected option. This behavior varies by prerequisites for each protocol. This option is available only if a FortiAnalyzer unit or FortiGuard Analysis and Management Service is configured.

Logging

You can enable logging in an MMS profile to write event log messages when the MMS profile options that you have enabled perform an action. For example, if you enable MMS antivirus protection, you could also use the MMS profile logging options to write an event log message every time a virus is detected.

You must first configure how the unit stores log messages so that you can then record these logs messages. For more information, see the FortiOS Handbook Logging and Reporting guide.

Logging	
MMS-Antivirus	If antivirus settings are enabled for this MMS profile, select the following options to record **Antivirus Log** messages.
Viruses	Record a log message when this MMS profile detects a virus.
Blocked Files	Record a log message when antivirus file filtering enabled in this MMS profile blocks a file.
Oversized Files/Emails	Record a log message when this MMS profile encounters an oversized file or email message. Oversized files and email messages cannot be scanned for viruses.
MMS Scanning	If MMS scanning settings are enabled for this MMS profile, select the following options to record **Email Filter Log** messages.
Notification Messages	Select to log the number of MMS notification messages sent.

Logging	
Bulk Messages	Select to log MMS Bulk AntiSpam events. You must also select which protocols to write log messages for in the MMS bulk email filtering part of the MMS profile.
Carrier Endpoint Filter Block	Select to log MMS carrier endpoint filter events, such as MSISDN filtering.
MMS Content Checksum	Select to log MMS content checksum activity.
Content Block	Select to log content blocking events.

MMS Content Checksum

The MMS Content Checksum menu allows you to configure content checksum lists.

Configure MMS content checksum lists in **Security Profiles > MMS Content Checksum** using the following table.

MMS Content Checksum Lists each individual content checksum list that you created. On this page, you can edit, delete or create a content checksum list.	
Create New	Creates a new MMS content checksum list. When you select **Create New**, you are automatically redirected to the New List. This page provides a name field and comment field. You must enter a name to go to MMS Content Checksum Settings page.
Edit	Modifies settings to a MMS content checksum. When you select **Edit**, you are automatically redirected to the MMS Content Checksum Settings page.
Delete	Removes an MMS content checksum from the page. To remove multiple content checksum lists from within the list, on the MMS Content Checksum page, in each of the rows of the content checksum lists you want removed, select the check box and then select **Delete**. To remove all content checksum lists from list, on the MMS Content Checksum page, select the check box in the check box column and then select **Delete**.
Name	The name of the MMS content checksum list that you created.
# Entries	The number of checksums that are included in the content checksum list.

MMS Profiles	The MMS profile or profiles that have the MMS content checksum list applied. For example if two different MMS profiles use this content checksum list, they will both be listed here.
Comments	A description given to the MMS content checksum.
Ref.	Displays the number of times the object is referenced to other objects. For example, av_1 profile is applied to a security policy; on the Profile page (**Security Profiles > AntiVirus > Profiles**), 1 appears in **Ref.** . To view the location of the referenced object, select the number in **Ref.**, and the Object Usage window appears displaying the various locations of the referenced object. To view more information about how the object is being used, use one of the following icons that is available within the Object Usage window: • **View the list page for these objects** – automatically redirects you to the list page where the object is referenced at. • **Edit this object** – modifies settings within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy and so, when this icon is selected, the user is redirected to the Edit Policy page. • **View the details for this object** – table, similar to the log viewer table, contains information about what settings are configured within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy, and that security policy's settings appear within the table.

Notification List

The Notification List menu allows you to configure a list of viruses. This virus list provides a list for scanning viruses in MMS messages. You can use one virus list in multiple MMS profiles, and configure multiple virus lists.

Notification list configuration settings

The following are notification list configuration settings in **Security Profiles > Notification List**.

Notification List Lists all the notification lists that you created. On this page you can edit, delete or create a new notification list.	
Create New	Creates a new notification list. When you select **Create New**, you are automatically redirected to the New List page. You must enter a name to go to the Notification List Settings page.

Edit	Modifies settings within the notification list. When you select **Edit**, you are automatically redirected to the Notification List Settings page.
Delete	Removes a notification list from the list on the Notification List page. To remove multiple notification lists from within the list, on the Notification List page, in each of the rows of the notification lists you want removed, select the check box and then select **Delete**. To remove all notification lists from the list, on the Notification List page, select the check box in the check box column and then select **Delete**.
Name	The name of the MMS content checksum list that you created.
# Entries	The number of checksums that are included in that content checksum list.
MMS Profiles	The MMS profile or profiles that are associated with
Comments	A description given to the MMS notification list.
Ref.	Displays the number of times the object is referenced to other objects. For example, av_1 profile is applied to a security policy; on the Profile page (**Security Profiles > Antivirus > Profiles**), 1 appears in **Ref.** . To view the location of the referenced object, select the number in **Ref.**, and the Object Usage window appears displaying the various locations of the referenced object. To view more information about how the object is being used, use one of the following icons that is available within the Object Usage window: • **View the list page for these objects** – automatically redirects you to the list page where the object is referenced at. • **Edit this object** – modifies settings within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy and so, when this icon is selected, the user is redirected to the Edit Policy page. • **View the details for this object** – table, similar to the log viewer table, contains information about what settings are configured within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy, and that security policy's settings appear within the table.

Notification List Settings

Provides settings for configuring a notification list, which is a list of viruses and is used for scanning viruses in MMS messages. This list is called the Antivirus Notification List in an MMS profile.

Name	If editing the name of a notification list, enter the new name in this field. You must select **OK** to save the change.
Comments	If you want to enter a comment, enter the comment in the field. You must select **OK** to save the change.
Create New	Creates a notification entry in the list. When you select **Create New**, you are automatically redirected to the New Entry page.
Edit	Modifies settings within a notification list. When you select **Edit**, you are automatically redirected to the Edit Entry page.
Delete	Removes a notification entry from the list on the page. To remove multiple notification entries from within the list, on the Notification List Settings page, in each of the rows of the entries you want removed, select the check box and then select **Delete**. To remove all notification entries from the list, on the Notification List Settings page, select the check box in the check box column and then select **Delete**.
Enable	Enables a notification entry that is disabled.
Disable	Disables a notification entry so that it is not active and available for use, but it is not deleted.
Remove All Entries	Removes all notification entries that are listed on the Notification List Settings page.
Enable	Displays whether or not the checksum is enabled.
Virus Name/Profile	The name of the virus that was added to the list.
Entry Type	The type of match that will be used to match the virus stated in the notification list to the actual virus that is found.
New Entry page	
Virus Name/Profile	Enter the virus name.
Entry Type	Select the type of match that will be used to match the virus stated in the notification list to the actual virus that is found.
Enable	Select to enable the virus in the list.

Message Flood

The convenience offered by MM1 and MM4 messaging can be abused by users sending spam or attempting to overload the network with an excess of messages. MMS flood prevention can help prevent this type of abuse. A message flood occurs when a single subscriber sends a volume of messages that exceed the flood threshold that you set. The threshold defines the maximum number of messages allowed, the period during which the subscriber sent messages are considered, and the length of time the sender is restricted from sending messages after a flood is detected. For example, for the first threshold you may determine that any subscriber who sends more than 100 MM1 messages in an hour (60 minutes) will have all outgoing messages blocked for 30 minutes.

Action	Description
Log	Add a log entry indicating that a message flood has occurred. You must also enable logging by going to **Security Profiles > MMS Profile**, <applicable profile> **> Logging > MMS Scanning > Bulk Messages**, and toggling on the checkbox.
DLP Archive	Save the first message to exceed the flood threshold, or all the messages that exceed the flood threshold, in the DLP archive. DLP archiving flood messages may not always produce useful results. Since different messages can be causing the flood, reviewing the archived messages may not be a good indication of what is causing the problem since the messages could be completely random.
All messages	All the messages that exceed the flood threshold will be saved in the DLP archive.
First message only	Save only the first message to exceed the flood threshold in the DLP archive. Other messages in the flood are not saved. For message floods this may not produce much useful information since a legitimate message could trigger the flood threshold.
Intercept	Messages that exceed the flood threshold are passed to the recipients, but if quarantine is enabled for intercepted messages, a copy of each message will also quarantined for later examination. If the quarantine of intercepted messages is disabled, the **Intercept** action has no effect.
Block	Messages that exceed the flood threshold are blocked and will not be delivered to the message recipients. If quarantine is enabled for blocked messages, a copy of each message will quarantined for later examination.
Alert Notification	If the flood threshold is exceeded, the Carrier-enabled FortiGate unit will send an MMS flood notification message. In the web-based manager when **Alert Notification** is selected it displays the fields to configure the notification.

Flood protection for MM1 messages prevents your subscribers from sending too many messages to your MMSC. Configuring flood protection for MM4 messages prevents another service provider from sending too many messages from the same subscriber to your MMSC.

Message flood configuration settings

The following are message flood configuration settings in **Security Profiles > Message Flood**.

Message Flood	
Lists the large amount of messages that are being sent to you from outside sources.	
Delete	Removes messages from the list. To remove multiple messages from within the list, on the Message Flood page, in each row of the messages you want removed, select the check box and then select **Delete**. To remove all messages from the list, on the Message Flood page, select the check box in the check box column and then select **Delete**.
Remove All Entries	Removes all messages from the list.
Protocol	Sorts/filters by the protocol used.
MMS Profile	Sorts/filters by the MMS profile that is used.
Sender	Sorts/filters by the sender's email address.
Level	Sorts/filters by he level of severity of the message.
Count	The count column can be up or down and these settings can be turned off by selecting beside the column's name.
Window Size (minutes)	The time in minutes.
Timer (minutes:seconds)	The time in seconds and in minutes. The timer column can be up or down and these settings turned off by selecting beside the column's name.
Page Controls	Use to navigate through the list.

Duplicate Message

Duplicate message protection for MM1 messages prevents multiple subscribers from sending duplicate messages to your MMSC. Duplicate message protection for MM4 messages prevents another service provider from sending duplicate messages from the same subscriber to your MMSC.

The unit keeps track of the sent messages. If the same message appears more often than the threshold value that you have configured, action is taken. Possible actions are logging the duplicate messages, blocking or

intercepting them, archiving, and sending an alert to inform an administrator that duplicate messages are occurring.

Duplicate message configuration settings

View duplicate messages in **Security Profiles > Duplicate Message**.

Duplicate Message	
Lists duplicates of messages that were sent to you.	
Delete	Removes a message from the list. To remove multiple duplicate messages from within the list, on the Message Flood page, in each row of the messages you want removed, select the check box and then select **Delete**. To remove all duplicate messages from the list, on the Message Flood page, select the check box in the check box column and then select **Delete**.
Page Controls	Use to navigate through the list.
Remove All Entries	Removes all duplicate messages from the list.
Protocol	Sorts/filters by the protocol used.
MMS Profile	Sorts/filters by the MMS profile that logs the detection.
Checksum	Sorts/filters by the checksum of the MMS message.
Level	Sorts/filters by he level of severity of the message.
Count	Displays the number of messages in the last window of time.
Window Size (minutes)	The period of time during which a message flood will be detected if the Message Flood Limit is exceeded.
Timer (minutes:seconds)	Either the time left in the window if the message is unflagged, or the time until the message will be unflagged if it is already flagged.

Carrier Endpoint Filter Lists

A carrier endpoint filter list contains carrier endpoint patterns. A pattern can match one carrier endpoint or can use wildcards or regular expressions to match multiple carrier endpoints. For each pattern, you select the action that the unit takes on a message when the pattern matches a carrier endpoint in the message. Actions include blocking the message, exempting the message from MMS scanning, and exempting the message from all scanning. You can also configure the pattern to intercept the message and content archive the message to a FortiAnalyzer unit.

Carrier endpoint filter lists configuration settings

The following are Carrier endpoint filter list configuration settings in **Security Profiles > Carrier Endpoint Filter Lists**.

Carrier Endpoint Filter Lists Lists all the endpoint filters that you created. On this page, you can edit, delete or create a new endpoint filter list.	
Create New	Creates a new endpoint filter list. When you select **Create New**, you are automatically redirected to the New List page. You must enter a name to go to the Carrier Endpoint Filter Lists Settings page.
Edit	Modifies settings within an endpoint filter list in the list.
Delete	Removes an endpoint filter in the list. To remove multiple endpoint filter lists from within the list, on the Carrier Endpoint Filter List page, in each of the rows of the endpoint filter lists you want removed, select the check box and then select **Delete**. To remove all endpoint filter lists from the list, on the Carrier Endpoint Filter List page, select the check box in the check box column and then select **Delete**.
Name	The name of the endpoint filter.
# Entries	The number of carrier endpoint patterns in each carrier endpoint filter list.
MMS Profiles	The MMS profile that the carrier endpoint filter list is added to.
Comments	A description about the endpoint filter.

Ref.	Displays the number of times the object is referenced to other objects. For example, av_1 profile is applied to a security policy; on the Profile page (**Security Profiles > Antivirus > Profiles**), 1 appears in **Ref.** . To view the location of the referenced object, select the number in **Ref.**, and the Object Usage window appears displaying the various locations of the referenced object. To view more information about how the object is being used, use one of the following icons that is available within the Object Usage window: • **View the list page for these objects** – automatically redirects you to the list page where the object is referenced at. • **Edit this object** – modifies settings within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy and so, when this icon is selected, the user is redirected to the Edit Policy page. • **View the details for this object** – table, similar to the log viewer table, contains information about what settings are configured within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy, and that security policy's settings appear within the table.
Carrier Endpoint Filter Lists Settings Provides settings for configuring an endpoint filter.	
Name	The name you entered on the New List page, after selecting **Create New** on the Carrier Endpoint Filter page.
Comments	A description about the endpoint filter. You can add one here if you did not enter one on the New List page.
Create New	Creates a new endpoint filter list. When you select **Create New**, you are automatically redirected to the New Entry page.
Edit	Select to modify the settings of a pattern in the list.
Delete	Select to remove a pattern in the list.
Enable	Enables a disabled pattern in the list.
Disable	Disables a pattern in the list.
Remove All Entries	Removes all patterns in the list on the Carrier Endpoint Filter Lists Settings page.
Enable	Indicates whether or not the pattern is enabled.

Pattern	Enter or change the pattern that FortiOS Carrier uses to match with carrier endpoints. The pattern can be a single carrier endpoint or consist of wildcards or Perl regular expressions that will match more than one carrier endpoint. Set **Pattern Type** to correspond to the pattern that you want to use.
Action	Select the action taken by FortiOS Carrier for messages from a carrier endpoint that matches the carrier endpoint pattern:
Pattern Type	The type of pattern chosen.
New Entry page	
Pattern	Enter or change the pattern that FortiOS Carrier uses to match with carrier endpoints. The pattern can be a single carrier endpoint or consist of wildcards or Perl regular expressions that will match more than one carrier endpoint. Set **Pattern Type** to correspond to the pattern that you want to use.
Action(s)	Select the action taken by FortiOS Carrier for messages from a carrier endpoint that matches the carrier endpoint pattern: Action(s) can be: • None • Block • Exempt from mass MMS • Exempt from all scanning
Content Archive	MMS messages from the carrier endpoint are delivered, the message content is DLP archived according to MMS DLP archive settings. Content archiving is also called DLP archiving.
Pattern Type	Select a pattern type as one of Single Carrier Endpoint, Wildcard or Regular Expression. Wildcard and Regular Expression will match multiple patterns where Single Carrier Endpoint matches only one.
Enable	Select to enable this carrier endpoint filter pattern.

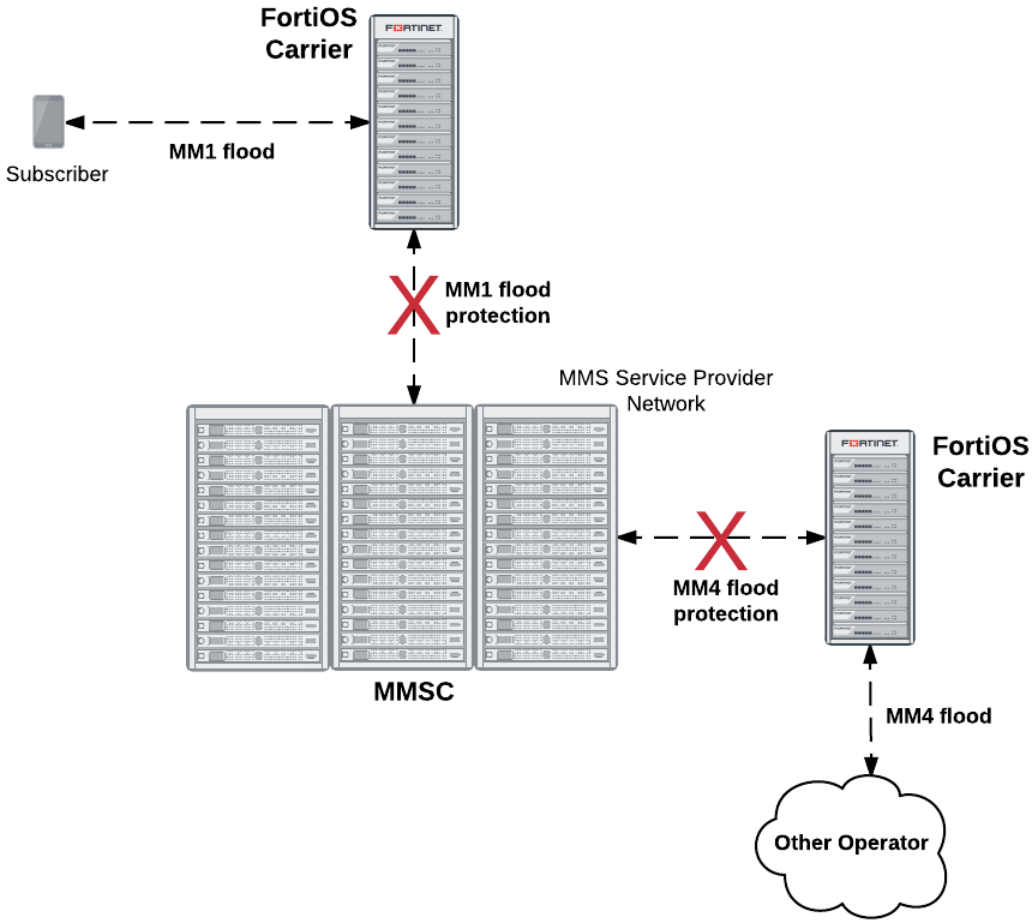
Message flood protection

The convenience offered by MM1 and MM4 messaging can be abused by users sending spam or attempting to overload the network with an excess of messages. MMS flood prevention can help prevent this type of abuse.

Overview

Flood protection for MM1 messages prevents your subscribers from sending too many messages to your MMSC. Configuring flood protection for MM4 messages prevents another service provider from sending too many messages from the same subscriber to your MMSC.

MM1 and MM4 flood protection



The FortiOS Carrier unit keeps track of the number of messages each subscriber sends for the length of time you specify. If the number of messages a subscriber sends exceeds the threshold, a configured action is taken. Possible actions are logging the flood, blocking or intercepting messages in the flood, archiving the flood messages, and sending an alert message to inform the administrator that the flood is occurring.

You can create three different thresholds to take different levels of action at different levels of activity.

With this highly configurable system, you can prevent subscribers from sending more messages than you determine is acceptable, or monitor anyone who exceeds the thresholds.

Setting message flood thresholds

A message flood occurs when a single subscriber sends a volume of messages that exceeds the flood threshold you set. The threshold defines the maximum number of messages allowed, the period during which the subscriber sent messages are considered, and the length of time the sender is restricted from sending messages after a flood is detected.

If a subscriber exceeds the message flood threshold and is blocked from sending more messages, any further attempts to send messages will re-start the block period. You must also enable logging for **MMS Scanning > Bulk Messages** in the Logging section of the MMS protection profile.

A subscriber is still able to receive messages while they are blocked from sending messages.

Example

For example, for the first threshold you may determine that any subscriber who sends more than 100 MM1 messages in an hour (60 minutes) will have all messages blocked for half an hour (30 minutes).

Using this example, if the subscriber exceeds the flood threshold, they are blocked from sending message for 30 minutes. If the subscriber tries to send any message after 15 minutes, the message will be blocked and the block period will be reset again to 30 minutes. The block period must expire with no attempts to send a message. Only then will the subscriber be allowed to send more messages.

To configure MM1 message flood threshold - web-based manager

1. Go to **Security Profiles > MMS Profile**.
2. Select **Create New**.
3. Enter `MM1 flood` for **Profile Name**.
4. Expand **MMS Bulk Email Filtering Detection**.
5. Enter the following information, and select **OK**.

MM1 (first column)	
Enable	Enable
Message Flood Window	60 minutes
Message Flood Limit	100
Message Flood Block Time	30 minutes
Message Flood Action	Block

To configure MM1 message flood threshold - CLI

```
config firewall mms-profile
   edit profile_name
      config flood mm1
         set status1 enable
         set window1 60
```

```
        set limit1 100
        set action1 block
        set block-time1 30
    end
end
```

The threshold values that you set for your network will depend on factors such as how busy your network is and the kinds of problems that your network and your subscribers encounter. For example, if your network is not too busy you may want to set message flood thresholds relatively high so that only an exceptional situation will exceed a flood threshold. Then you can use log messages and archived MMS messages to determine what caused the flood.

If your subscribers are experiencing problems with viruses that send excessive amounts of messages, you may want to set thresholds lower and enable blocking to catch problems as quickly as possible and block access to keep the problem from spreading.

Flood actions

When the Carrier-enabled FortiGate unit detects a message flood, it can take any combination of the five actions that you can configure for the flood threshold. For detailed options, see Message Flood.

Notifying administrators of floods

You can configure alert notifications for message floods by selecting the Alert Notification message flood action.

The FortiOS Carrier unit sends alert notifications to administrators using the MM1, MM3, MM4, or MM7 content interface. To send an alert notification you must configure addresses and other settings required for the content interface.

For example, to send notifications using the MM1 content interface you must configure a source MSISDN, hostname, URL, and port to which to send the notification. You can also configure schedules for when to send the notifications.

Finally you can add multiple MSISDN numbers to the MMS protection profile and set which flood thresholds to send to each MSISDN.

Example — three flood threshold levels with different actions for each threshold

You can set up to three threshold levels to take different actions at different levels of activity.

The first example threshold records log messages when a subscriber's handset displays erratic behavior by sending multiple messages using MM1 at a relatively low threshold. The erratic behavior could indicate a problem with the subscriber's handset. For example, you may have determined for your network that if a subscriber sends more the 45 messages in 30 minutes that you want to record log messages as a possible indication or erratic behavior.

From the web-based manager in an MMS profile set message **Flood Threshold 1** to:

Enable	Selected
Message Flood Window	30 minutes

Message Flood Limit	45
Message Flood Action	Log

From the CLI:

```
config firewall mms-profile
   edit profile_name
      config flood mm1
         set status1 enable
         set window1 30
         set limit1 45
         set action1 log
      end
   end
```

Set a second higher threshold to take additional actions when a subscriber sends more that 100 messages in 30 minutes. Set the actions for this threshold to log the flood, archive the message that triggered the second threshold, and block the sender for 15 minutes.

From the web-based manager in an MMS profile set message **Flood Threshold 2** to:

Enable	Selected
Message Flood Window	30 minutes
Message Flood Limit	100
Message Block Time	15 minutes
Message Flood Action	Log, DLP archive First message only, Block

From the CLI:

```
config firewall mms-profile
   edit profile_name
      config flood mm1
         set status2 enable
         set window2 30
         set limit2 100
         set action2 block log archive-first
         set block-time2 15
      end
   end
```

Set the third and highest threshold to block the subscriber for an extended period and sand an administrator alert if the subscriber sends more than 200 messages in 30 minutes. Set the actions for this threshold to block the sender for four hours (240 minutes), log the flood, archive the message that triggered the third threshold, and send an alert to the administrator.

From the web-based manager in an MMS profile set message **Flood Threshold 3** to:

Enable	Selected
Message Flood Window	30 minutes
Message Flood Limit	200
Message Block Time	240 minutes
Message Flood Action	Log, Block, Alert Notification

Because you have selected the **Alert Notification** action you must also configure alert notification settings. For this example, the source MSISDN is 5551234—telephone number 555-1234. When administrators receive MMS messages from this MSIDSN they can assume a message flood has been detected.

In this example, alert notifications are sent by the FortiOS Carrier unit to the MMSC using MM1. The host name of the MMSC is `mmscexample`, the MMSC URL is `/`, and the port used by the MMSC is 80. In this example, the alert notification window starts at 8:00am and extends for eight hours on weekdays (Monday-Friday) and the minimum interval between message flood notifications is two hours.

Source MSISDN	5551234
Message Protocol	MM1
Hostname	mmscexample
URL	/
Port	80
Notifications Per Second Limit	0
Window Start Time	8:00
Window Duration	8:00
Day of Week	Mon, Tue, Wed, Thu, Fri, Sat
Interval	2 hours

From the CLI:

```
config firewall mms-profile
   edit profile_name
      config notification alert-flood-1
         set alert-src-msisdn 5551234
         set msg-protocol mm1
         set mmsc-hostname mmscexample
         set mmsc-url /
         set mmsc-port 80
         set rate-limit 0
         set tod-window-start 8:00
```

```
        set tod-window-duration 8:00
        set days-allowed monday tuesday wednesday thursday friday
        set alert-int 2
        set alert-int-mode hours
    end
```

You must also add the MSISDNs of the administrators to be notified of the message flood. In this example, the administrator flood threshold 3 alert notifications are sent to one administrator with MSISDN 5554321.

To add administrator's MSISDNs for flood threshold 3 from the web-based manager when configuring a protection profile, select **MMS Bulk Email Filtering Detection > Recipient MSISDN > Create New**.

MSISDN	5554321
Flood Level 3	Select

From the CLI:

```
config firewall mms-profile
   edit profile_name
      config notif-msisdn
         edit 5554321
            set threshold flood-thresh-3
      end
end
```

Notifying message flood senders and receivers

The FortiOS Carrier unit does not send notifications to the sender or receiver that cause a message flood. If the sender or receiver is an attacker and is explicitly informed that they have exceeded a message threshold, the attacker may try to determine the exact threshold value by trial and error and then find a way around flood protection. For this reason, no notification is set to the sender or receiver.

However, FortiOS Carrier does have replacement messages for sending reply confirmations to MM1 senders and receivers and for MM4 senders for blocked messages identified as message floods. For information about how FortiOS Carrier responds when message flood detection blocks a message, see and MMS duplicate messages and message floods.

Responses to MM1 senders and receivers

When the FortiOS Carrier unit identifies an MM1 message sent by a sender to an MMSC as a flood message and blocks it, the FortiOS Carrier unit returns a message submission confirmation (`m-send.conf`) to the sender — otherwise the sender's handset would keep retrying the message. The `m-send.conf` message is sent only when the MM1 message flood action is set to Block. For other message flood actions the message is actually delivered to the MMSC and the MMSC sends the `m-send.conf` message.

You can customize the `m-send.conf` message by editing the **MM1 send-conf flood message** MM1 replacement message (from the CLI the `mm1-send-conf-flood` replacement message). You can customize the response status and message text for this message. The default response status is "Content not accepted". To hide the fact that FortiOS Carrier is responding to a flood, you can change the response status to "Success". The default message text informs the sender that the message was blocked. You could change this to something more generic.

For example, the following command sets the submission confirmation response status to “Success” and changes the message text to “Message Sent OK”:

```
config system replacemsg mm1 mm1-send-conf-flood
   set rsp-status ok
   set rsp-text “Message Sent OK”
end
```

When the FortiOS Carrier unit identifies an MM1 message received by a receiver from an MMSC as a flood message and blocks it, the FortiOS Carrier unit returns a message retrieval confirmation (m-retrieve.conf) to the sender (otherwise the sender’s handset would keep retrying the message). The m-retrieve.conf message is sent only when the MM1 message flood action is set to Block. For other message flood actions the message is actually delivered to the receiver, so the MMSC sends the m-retrieve.conf message.

You can customize the m-retrive.conf message by editing the **MM1 retrieve-conf flood message** MM1 replacement message (from the CLI the `mm1-retr-conf-flood` replacement message). You can customize the class, subject, and message text for this message.

For example, you could use the following command make the response more generic:

```
config system replacemsg mm1 mm1-retr-conf-flood
   set subject “Message blocked”
   set message “Message temporarily blocked by carrier”
end
```

Forward responses for MM4 message floods

When the FortiOS Carrier unit identifies an MM4 message as a flood message and blocks it, the FortiOS Carrier unit returns a message forward response (MM4_forward.res) to the forwarding MMSC (otherwise the forwarding MMSC would keep retrying the message). The MM4_forward.res message is sent only when the MM4 message flood action is set to Block and the MM4-forward.req message requested a response. For more information, see and MMS duplicate messages and message floods.

You can customize the MM4_forward.res message by editing the **MM4 flood message** MM4 replacement message (from the CLI the `mm4-flood` replacement message). You can customize the response status and message text for this message. The default response status is “Content not accepted” (`err-content-not-accept`). To hide the fact that the FortiOS Carrier unit is responding to a flood, you can change the response status to “Success”. The default message text informs the sender that the message was blocked. You could change this to something more generic.

For example, the following command sets the submission confirmation response status to “Success” and changes the message text to “Message Sent OK” for the MM4 message forward response

```
config system replacemsg mm4 mm4-flood
   set rsp-status ok
   set rsp-text “Message Forwarded OK”
end
```

Viewing DLP archived messages

If **DLP Archive** is a selected message flood action, the messages that exceed the threshold are saved to the MMS DLP archive. The default behavior is to save all of the offending messages, but you can configure the DLP archive setting to save only the first message that exceeds the threshold. This still provides a sample of the offending messages without requiring as requiring as much storage.

To select only the first message in a flood for DLP archiving - web-based manager

1. Go to **Security Profiles > MMS Profile**.
2. Edit an existing MMS Profile.
3. Expand the **MMS Bulk Email Filtering Detection** section, the **Message Flood** subsection, and the desired **Flood Threshold** subsection.
4. Next to **DLP Archive**, select **First message only** from the drop down menu.
5. Select **OK**.

Order of operations: flood checking before duplicate checking

Although duplicate checking involves only examination and comparison of message contents and not the sender or recipient, and flood checking involves only totaling the number of messages sent by each subscriber regardless of the message content, there are times when a selection of messages exceed both flood and duplicate thresholds.

The Carrier-enabled FortiGate unit checks for message floods before checking for duplicate messages. Flood checking is less resource-intensive and if the flood threshold invokes a **Block** action, the blocked messages are stopped before duplicate checking occurs. This saves both time and FortiOS Carrier system resources.

The duplicate scanner will only scan content. It will not scan headers. Content must be exactly the same. If there is any difference at all in the content, it will not be considered a duplicate.

Bypassing message flood protection based on user's carrier endpoints

You can use carrier endpoint filtering to exempt MMS sessions from message flood protection. Carrier endpoint filtering matches carrier endpoints in MMS sessions with carrier endpoint patterns.

If you add a carrier endpoint pattern to a filter list and set the action to exempt from mass MMS, all messages from matching carrier endpoints bypass message flood protection. This allows legitimate bulk messages, such as system outage notifications, to be delivered without triggering message flood protection.

For more information on carrier endpoints, see the User Authentication chapter of the FortiOS Handbook.

Configuring message flood detection

To have the Carrier-enabled FortiGate unit check for message floods, you must first configure the flood threshold in an MMS profile, select the MMS profile in a security policy. All the traffic examined by the security policy will be checked for message floods according to the threshold values you set in the MMS profile.

Configure the MMS profile - web-based manager

1. Go to **Firewall Objects > MMS Profile**.
2. If you are editing an MMS profile, select the **Edit** icon of the MMS profile.
   If you are creating a new MMS profile, select **Create New** and enter a profile name.
3. Expand **MMS Bulk Email Filtering Detection**.
4. Expand **Message Flood**.
5. Expand **Flood Threshold 1**.

6. Select the **Enable** check box for MM1 messages, MM4 messages, or both.
7. In the **Message Flood Window** field, enter the length of time the Carrier-enabled FortiGate unit will keep track of the number of messages each subscriber sends.

   If the Carrier-enabled FortiGate unit detects the quantity of messages specified in the **Message Flood Limit** sent during the number of minutes specified in the **Message Flood Window**, a message flood is in progress.
8. In the **Message Flood Limit** field, enter the number of messages required to trigger the flood.
9. In the **Message Flood Block Time** field, enter the length of time a user will be blocked from sending messages after causing the message flood.
10. Select the message flood actions the Carrier-enabled FortiGate unit will take when the message flood is detected.
11. Select **OK**.

Configure the security policy - web-based manager

1. Go to **Policy**.
2. Select the **Edit** icon of the security policy that controls the traffic in which you want to detect message floods.
3. Select the **MMS Profile** check box to enable the use of a protection profile.
4. Select the MMS protection profile from the list.
5. Select **OK**.

Sending administrator alert notifications

When message floods are detected, the Carrier-enabled FortiGate unit can be configured to notify you immediately with an MMS message. Enable this feature by selecting Alert Notification in the message flood action. Each message flood threshold can be configured separately.

Configuring how and when to send alert notifications

You can configure different alert notifications for MM1 and MM4 message floods. You can configure the FortiOS Carrier unit to send these alert notifications using the MM1, MM3, MM4, or MM7 content interface. Each of these content interfaces requires alert notification settings that the FortiOS Carrier unit uses to communicate with a server using the selected content interface.

For the MM1 content interface you require:

- The hostname of the server
- The URL of the server (usually “/”)
- The server port (usually 80)

For the MM3 and MM4 content interfaces you require:

- The hostname of the server
- The server port (usually 80)
- The server user domain

For the MM7 content interface you require:

- The message type
- ***submit.REQ*** to send a notification message to the sender in the form of a submit request. The message goes from a VAS application to the MMSC.

- ***deliver.REQ*** to send a notification message to the sender in the form of a deliver request. The message goes from the MMSC to a VAS application.
- The hostname of the server
- The URL of the server (usually "/")
- The server port (usually 80)
- A user name and password to connect to the server
- The value-added-service-provider (VASP) ID
- The value-added-service (VAS) ID

For more information, see MMS notifications.

To configure administrator alert notifications - web-based manager

1. Go to **Firewall Objects > MMS Profile** and edit or add a new MMS protection profile.
2. Expand **MMS Bulk Email Filtering Detection**.
   There are three message flood thresholds.
3. Expand the threshold that you want to configure alert notification for.
4. For **Message Flood Action**, select the **Alert Notification** check box. Alert notification options appear.
5. For the **Source MSISDN**, enter the MSISDN from which the alert notification message will be sent.
6. Select the Message Protocol the alert notification will use: **MM1**, **MM3**, **MM4**, or **MM7**.
7. Add the information required by FortiOS Carrier to send messages using the selected message protocol:
8. For **Notifications Per Second Limit**, enter the number of notifications to send per second.
   Use this setting to reduce control the number of notifications sent by the FortiOS Carrier unit. If you enter zero (0), the notification rate is not limited.
9. If required, change **Window Start Time** and **Window Duration** configure when the FortiOS Carrier unit sends alert notifications.
   By default, notifications are sent at any time of the day. You can change the Window Start Time if you want to delay sending alert messages. You can also reduce the Window Duration if you want to stop sending alert notifications earlier.

   For example, you might not want FortiOS Carrier sending notifications except during business hours. In this case the Window Start Time could be 9:00 and the Window Duration could be 8:00 hours.

   You can set different alert notifications for each message threshold. For example, you could limit the message window for lower thresholds and set it to 24 hours for higher thresholds. This way administrators will only receive alert notifications outside of business hours for higher thresholds.
10. For **Day of Week**, select the days of the week to send notifications.
    For example, you may only want to send alert notifications on weekends for higher thresholds.
11. In the **Interval field**, enter the maximum frequency that alert notification messages will be sent, in minutes or hours.
    All alerts occurring during the interval will be included in a single alert notification message to reduce the number of alert messages that are sent.

Configuring who to send alert notifications to

In each MMS protection profile you add a list of recipient MSISDNs. For each of these MSISDNs you select the message flood threshold that triggers sending notifications to this MSISDN.

To configure the alert notification recipients - web-based manager

1. Go to **Firewall Objects > MMS Profile**.
2. Select the **Edit** icon of the MMS profile in which you want to configure the alert notification recipients.
3. Expand **MMS Bulk Email Filtering Detection**.
4. Expand **Recipient MSISDN**.
5. Select **Create New**.
6. In the **New MSISDN** window, enter the MSISDN to use for flood threshold alert notification.
7. Select the duplicate thresholds at which to send alert notifications to the MSISDN.

For the flood threshold to be able to send an alert notification to the MSISDN, the alert notification action must be enabled and configured within the flood threshold.

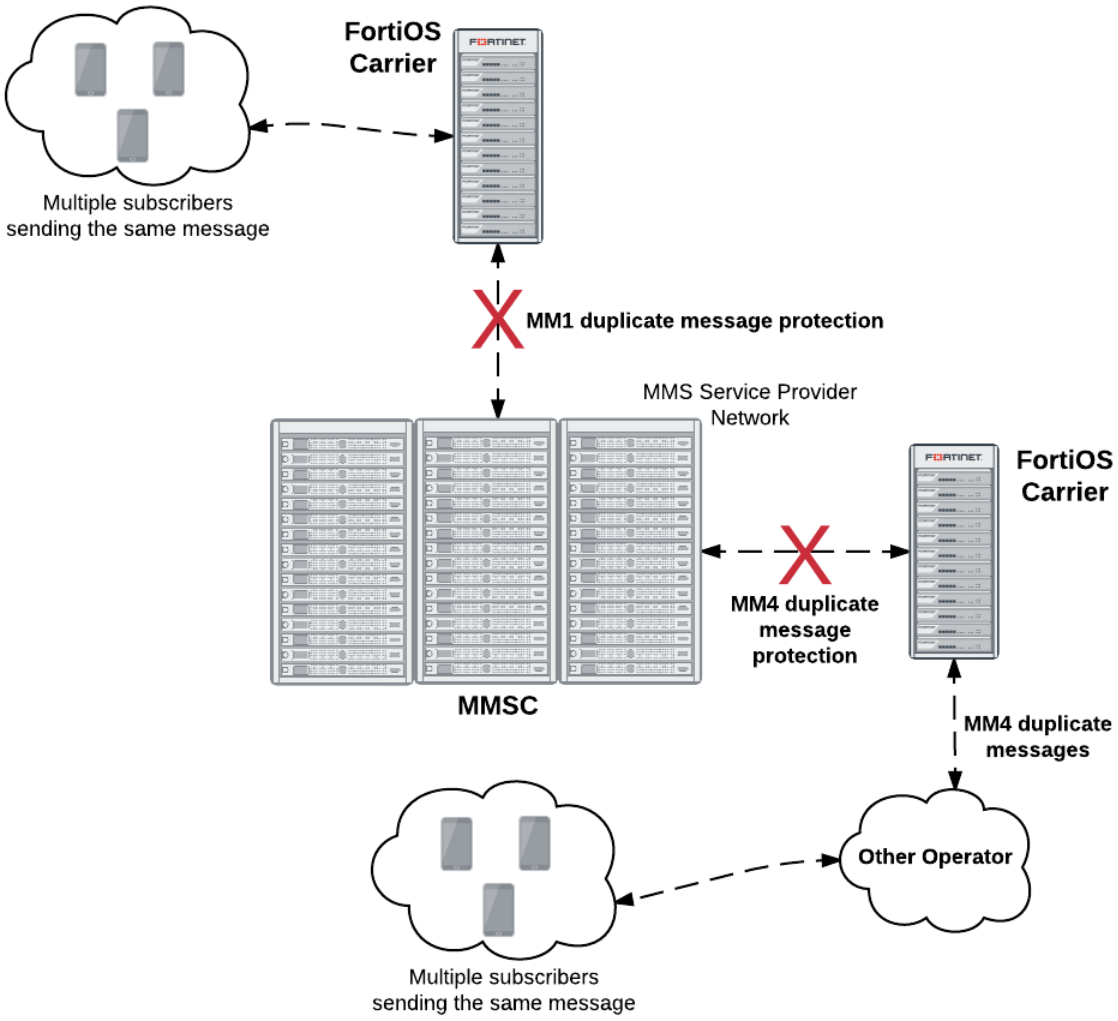
Duplicate message protection

The convenience offered by MM1 and MM4 messaging can be abused by users sending spam or other unwanted messages. Often, the same message will be sent by multiple subscribers. The message can be spam, viral marketing, or worm-generated messages. MMS duplicate prevention can help prevent this type of abuse by keeping track of the messages being sent.

Overview

Duplicate message protection for MM1 messages prevents multiple subscribers from sending duplicate messages to your MMSC. Duplicate message protection for MM4 messages prevents another service provider from sending duplicate messages from the same subscriber to your MMSC. This can help prevent a potential flood that would otherwise become widespread between carriers.

MM1 and MM4 duplicate message protection



The FortiOS Carrier unit keeps track of the sent messages. If the same message appears more often than the threshold value you configure, then action is taken. Possible actions are logging the duplicates, blocking or intercepting duplicate messages, archiving the duplicate messages, and sending an alert to inform an administrator that duplicates are occurring.

With this highly configurable system, you can prevent the transmission of duplicate messages when there are more than you determine is acceptable.

For detailed configuration options, see Duplicate Message.

Using message fingerprints to identify duplicate messages

The Carrier-enabled FortiGate unit detects duplicates by keeping a record of all the messages travelling on the network and comparing new messages to those that have already been sent.

Rather than save the messages, the FortiOS carrier creates a checksum using the message body and subject. This serves as a fingerprint to identify the message. If another message with the same message body and subject appears, the fingerprint will also be the same and the Carrier-enabled FortiGate unit will recognize it as a duplicate.

By creating and saving message fingerprints instead of saving the messages, the Carrier-enabled FortiGate unit can save resources and time.

Messages from any sender to any recipient

Duplicate message detection will detect duplicate messages regardless of the sender or recipient. To do this, message fingerprints are generated using only the message body and subject. The sender, recipient, and other header information is not included.

If multiple messages appear with the same subject and message body, the Carrier-enabled FortiGate unit will recognize them as being the same.

Setting duplicate message thresholds

The FortiOS Carrier recognizes all duplicate messages, but it will take action when it detects a volume of duplicate messages that exceed the duplicate threshold you set. The threshold defines the maximum number of duplicate messages allowed, the period during which the messages are considered, and the length of time the duplicate message can not be sent by anyone.

For example, you may determine that once a duplicate message is sent more than 300 times in an hour, any attempt to send the same duplicate message will be blocked for 30 minutes.

If a particular duplicate message exceeds the duplicate message threshold and is blocked, any further attempts to send the same message will re-start the block period.

Using the example above, if the duplicate message count exceeds the duplicate threshold, any attempt to send a copy of the duplicate message will be blocked for 30 minutes. If a subscriber tries to send a copy of the message after waiting 15 minutes, the message will be blocked and the block period will be reset to 30 minutes. The block period must expire with no attempts to send a duplicate message. Only then will a subscriber be allowed to send the message. Non-duplicate messages will not reset the block period.

Duplicate message actions

When the Carrier-enabled FortiGate unit detects that a duplicate message has exceeded duplicate threshold, it can take any combination of the five actions you configure for the duplicate threshold.

Action	Description
Log	Add a log entry indicating that a duplicate message event has occurred. You must also enable logging for **MMS Scanning > Bulk Messages** in the **Logging** section of the MMS protection profile.
DLP Archive	

Action		Description
	All messages	Save all the messages that exceed the duplicate threshold in the DLP archive.
	First message only	Save the first message to exceed the duplicate threshold in the DLP archive. Subsequent messages that exceed the duplicate threshold will not be saved.
Intercept		Messages that exceed the duplicate threshold are passed to the recipients, but if quarantine is enabled for intercepted messages, a copy of each message is also quarantined for later examination. If the quarantine of intercepted messages is disabled, the **Intercept** action has no effect.
Block		Messages that exceed the duplicate threshold are blocked and will not be delivered to the message recipients. If quarantine is enabled for blocked messages, a copy of each blocked message is quarantined for later examination.
Alert Notification		If the duplicate threshold is exceeded, the Carrier-enabled FortiGate unit will send an MMS duplicate message notification message.

Notifying duplicate message senders and receivers

The FortiOS Carrier unit does not send notifications to the sender or receiver of duplicate messages. If the sender or receiver is an attacker and is explicitly informed that they have exceeded a message threshold, the attacker may try to determine the exact threshold value by trial and error and then find a way around duplicate message protection. For this reason, no notification is set to the sender or receiver.

However, the FortiOS Carrier unit does have replacement messages for sending reply confirmations to MM1 senders and receivers and for MM4 senders for blocked messages identified as duplicate messages. For information about how FortiOS Carrier responds when message flood detection blocks a message, see and MMS duplicate messages and message floods.

Responses to MM1 senders and receivers

When the FortiOS Carrier unit identifies an MM1 message sent by a sender to an MMSC as a duplicate message and blocks it, the FortiOS Carrier unit returns a message submission confirmation (m-send.conf) to the sender (otherwise the sender's handset would keep retrying the message). The m-send.conf message is sent only when the MM1 duplicate message action is set to Block. For other duplicate message actions the message is actually delivered to the MMSC and the MMSC sends the m-send.conf message.

You can customize the m-send.conf message by editing the **MM1 send-conf duplicate message** MM1 replacement message (from the CLI the `mm1-send-conf-dupe` replacement message). You can customize the response status and message text for this message. The default response status is "Content not accepted". To hide the fact that the FortiOS Carrier unit is responding to a duplicate message, you can change the response status to "Success". The default message text informs the sender that the message was blocked. You could change this to something more generic.

For example, the following command sets the submission confirmation response status to “Success” and changes the message text to “Message Sent OK”:

```
config system replacemsg mm1 mm1-send-conf-dupe
   set rsp-status ok
   set rsp-text "Message Sent OK"
end
```

When the FortiOS Carrier unit identifies an MM1 message received by a receiver from an MMSC as a duplicate message and blocks it, the FortiOS Carrier unit returns a message retrieval confirmation (m-retrieve.conf) to the sender (otherwise the sender’s handset would keep retrying). The m-retrieve.conf message is sent only when the `MM1duplicate` message action is set to Block. For other message flood actions the message is actually received by the receiver, so the MMSC sends the m-retrieve.conf message.

You can customize the m-retrive.conf message by editing the **MM1 retrieve-conf duplicate message** MM1 replacement message (from the CLI the `mm1-retr-conf-dupe` replacement message). You can customize the class, subject, and message text for this message.

For example, you could use the following command make the response more generic:

```
config system replacemsg mm1 mm1-retr-conf-dupe
   set subject "Message blocked"
   set message "Message temporarily blocked by carrier"
end
```

Forward responses for duplicate MM4 messages

When the FortiOS Carrier unit identifies an MM4 message as a duplicate message and blocks it, the FortiOS Carrier unit returns a message forward response (MM4_forward.res) to the forwarding MMSC (otherwise the forwarding MMSC would keep retrying the message). The MM4_forward.res message is sent only when the MM4 duplicate message action is set to Block and the MM4-forward.req message requested a response. For more information, see and MMS duplicate messages and message floods.

You can customize the MM4_forward.res message by editing the **MM4 duplicate message** MM4 replacement message (from the CLI the `mm4-dupe` replacement message). You can customize the response status and message text for this message. The default response status is “Content not accepted” (`err-content-not-accept`). To hide the fact that the FortiOS Carrier unit is responding to a duplicate message, you can change the response status to “Success”. The default message text informs the sender that the message was blocked. You could change this to something more generic.

For example, the following command sets the submission confirmation response status to “Success” and changes the message text to “Message Forwarded OK”:

```
config system replacemsg mm4 mm4-dupe
   set rsp-status ok
   set rsp-text "Message Forwarded OK"
end
```

Viewing DLP archived messages

If **DLP Archive** is a selected duplicate message action, the messages that exceed the threshold are saved to the MMS DLP archive. The default behavior is to save all of the offending messages but you can configure the DLP archive setting to save only the first message that exceeds the threshold. See Viewing DLP archived messages.

Order of operations: flood checking before duplicate checking

Although duplicate checking involves only examination and comparison of message contents and not the sender or recipient, and flood checking involves only totalling the number of messages sent by each subscriber regardless of the message content, there are times when a selection of messages exceed both flood and duplicate thresholds.

The Carrier-enabled FortiGate unit checks for message floods before checking for duplicate messages. Flood checking is less resource-intensive and if the flood threshold invokes a **Block** action, the blocked messages are stopped before duplicate checking occurs. This saves both time and FortiOS Carrier system resources.

Bypassing duplicate message detection based on user's carrier endpoints

You can use carrier endpoint filtering to exempt MMS sessions from duplicate message detection. Carrier endpoint filtering matches carrier endpoints in MMS sessions with carrier endpoint patterns. If you add a carrier endpoint pattern to a filter list and set the action to exempt from mass MMS, all messages from matching carrier endpoints bypass duplicate message detection. For more information about endpoints, see FortiOS Handbook User Authentication guide.

Configuring duplicate message detection

To have the Carrier-enabled FortiGate unit check for duplicate messages, configure the duplicate threshold in an MMS profile, and select the MMS profile in a security policy.

All traffic matching the security policy will be checked for duplicate messages according to the settings in the MMS profile.

The duplicate scanner will only scan content. It will not scan headers. Content must be exactly the same. If there is any difference at all in the content, it will not be considered a duplicate.

The modular nature of the profiles allows you great flexibility in how you configure the scanning options. MMS profiles can be used in any number of policies, with different GTP profiles.

In a complex configuration, there may be many security policies, each with a different MMS profile. For a simpler network, you may have many security policies all using the same MMS profile.

Sending administrator alert notifications

When duplicate messages are detected, the Carrier-enabled FortiGate unit can be configured to notify you immediately with an MMS message. Enable this feature by selecting Alert Notification in the duplicate message action. Each duplicate message threshold can be configured separately.

Configuring how and when to send alert notifications

You can configure different alert notifications for MM1 and MM4 duplicate messages. You can configure the FortiOS Carrier unit to send these alert notifications using the MM1, MM3, MM4, or MM7 content interface. Each of these content interfaces requires alert notification settings that the FortiOS Carrier unit uses to communicate with a server using the selected content interface.

For the MM1 content interface you require:

- The hostname of the server
- The URL of the server (usually “/”)
- The server port (usually 80)

For the MM3 and MM4 content interfaces you require:

- The hostname of the server
- The server port (usually 80)
- The server user domain

For the MM7 content interface you require:

- The message type
- **submit.REQ** to send a notification message to the sender in the form of a submit request. The message goes from a VAS application to the MMSC.
- **deliver.REQ** to send a notification message to the sender in the form of a deliver request. The message goes from the MMSC to a VAS application.
- The hostname of the server
- The URL of the server (usually “/”)
- The server port (usually 80)
- A user name and password to connect to the server
- The value-added-service-provider (VASP) ID
- The value-added-service (VAS) ID

To configure administrator alert notifications - web-based manager

1. Go to **Security Profiles > MMS Profile** and edit or add a new MMS protection profile.
2. Expand **MMS Bulk Email Filtering Detection**.
   There are three duplicate message thresholds.
3. Expand the threshold that you want to configure alert notification for.
4. For **Duplicate Message Action**, select the **Alert Notification** check box. Alert notification options appear.
5. For the **Source MSISDN**, enter the MSISDN from which the alert notification message will be sent.
6. Select the Message Protocol the alert notification will use: **MM1**, **MM3**, **MM4**, or **MM7**.
7. Add the information required by FortiOS Carrier to send messages using the selected message protocol:
8. For **Notifications Per Second Limit**, enter the number of notifications to send per second.
   Use this setting to reduce control the number of notifications sent by the FortiOS Carrier unit. If you enter zero (0), the notification rate is not limited.
9. If required, change **Window Start Time** and **Window Duration** configure when the FortiOS Carrier unit sends alert notifications.
   By default, notifications are sent at any time of the day. You can change the Window Start Time if you want to delay sending alert messages. You can also reduce the Window Duration if you want to stop sending alert notifications earlier.

   For example, you might not want FortiOS Carrier sending notifications except during business hours. In this case the Window Start Time could be 9:00 and the Window Duration could be 8:00 hours.

You can set different alert notifications for each message threshold. For example, you could limit the message window for lower thresholds and set it to 24 hours for higher thresholds. This way administrators will only receive alert notifications outside of business hours for higher thresholds.

10. For **Day of Week**, select the days of the week to send notifications.
    For example, you may only want to send alert notifications on weekends for higher thresholds.
11. In the **Interval field**, enter the maximum frequency that alert notification messages will be sent, in minutes or hours.
    All alerts occurring during the interval will be included in a single alert notification message to reduce the number of alert messages that are sent.

Configuring who to send alert notifications to

In each MMS protection profile you add a list of recipient MSISDNs. For each of these MSISDNs you select the duplicate threshold that triggers sending notifications to this MSISDN.

To configure the alert notification recipients - web-based manager

1. Go to **Security Profiles > MMS Profile**.
2. Select the **Edit** icon of the MMS profile in which you want to configure the alert notification recipients.
3. Expand **MMS Bulk Email Filtering Detection**.
4. Expand **Recipient MSISDN**.
5. Select **Create New**.
6. In the **New MSISDN** window, enter the MSISDN to use for duplicate threshold alert notification.

Select the duplicate thresholds at which to send alert notifications to the MSISDN.

For the duplicate threshold to be able to send an alert notification to the MSISDN, the duplicate message threshold alert notification action must be enabled and configured.

Employing MMS Security features

FortiOS Carrier includes all the Security features of FortiOS with extra features specific to MMS carrier networks.

This section includes:

Why scan MMS messages for viruses and malware?

The requirement for scanning MM1 content comes from the fact that MMS is an increasingly popular technique for propagating malware between mobile devices.

Example: COMMWARRIOR

This is a virus for Series 60 type cell phones, such as Nokia, operating Symbian OS version 6 [or higher]. The object of the virus is to spread to other phones using Bluetooth and MMS as transport avenues. The targets are selected from the contact list of the infected phone and also sought via Bluetooth searching for other Bluetooth-enabled devices (phones, printers, gaming devices etc.) in the proximity of the infected phone.

This virus is more than a proof of concept - it has proven successfully its ability to migrate from a zoo collection to being in-the-wild. Currently, this virus is being reported in over 18 different countries around Europe, Asia and North America.

When the virus first infects a cell phone, a prompt is displayed asking the recipient if they want to install “Caribe”. Symptoms of an infected phone may include rapid battery power loss due to constant efforts by the virus to spread to other phones via a Bluetooth seek-and-connect outreach.

The following variants among others are currently scanned by the FortiOS Carrier devices, in addition to more signatures that cover all known threats.

- **SymbOS/COMWAR.V10B!WORM**
- Aliases: SymbOS.Commwarrior.B, SymbOS/Commwar.B, SymbOS/Commwar.B!wm, SymbOS/Commwar.B-net, SymbOS/Commwarrior.b!sis, SymbOS/Comwar.B, SymbOS/Comwar.B!wm, SymbOS/Comwar.B-wm, SYMBOS_COMWAR.B, SymbOS/Comwar.1.0.B!wormSYMBOS/COMWAR.V10B.SP!WORM [Spanish version]
- First Discovered In The Wild: July 04, 2007
- Impact Level: 1
- Virus Class: Worm
- Virus Name Size: 23,320
- **SymbOS/Commwar.A!worm**
- Aliases: Commwarrior-A, SymbOS.Commwarrior.A [NAV], SymbOS/Commwar.A-net, SymbOS/Commwar_ezboot.A-ne, SymbOS/Comwar.A, SymbOS/Comwar.A-wm, SYMBOS_COMWAR.A [Trend]
- First Discovered In The Wild: May 16 2005
- Impact Level: 1
- Virus Class: Worm
- Virus Name Size: 27,936
- SymbOS/Commwarriie.C-wm
- Aliases: None
- First Discovered In The Wild: Oct 17 2005
- Impact Level: 1
- Virus Class: File Virus
- Virus Name Size: None

For the latest list of threats Fortinet devices detect, visit the FortiGuard Center.

MMS virus scanning

You can use MMS virus scanning to scan content contained within MMS messages for viruses. FortiOS Carrier virus scanning can be applied to the MM1, MM3, MM4, and MM7 interfaces to detect and remove content containing viruses at many points in an MMS network. Perhaps the most useful interface to apply virus scanning would be the MM1 interface to block viruses sent by mobile users before they get into the service provider network.

To go to MMS virus scanning, go to **Security Profiles MMS Profile**, select an existing or create a new profile, and expand **MMS Scanning**. See MMS scanning options.

This section includes:

- MMS virus monitoring
- MMS virus scanning blocks messages (not just attachments)

MMS virus monitoring

To enable MMS virus monitoring, expand **MMS Scanning** and enable **Monitor only** for the selected MMS types.

This feature causes the FortiOS Carrier unit to record log messages when MMS scanning options find a virus, match a file name, or match content using any of the other MMS scanning options. Selecting this option enables reporting on viruses and other problems in MMS traffic without affecting users.

MMS virus scanning blocks messages (not just attachments)

To enable MMS virus scanning, expand **MMS Scanning** and enable **Virus Scan** for the selected MMS types.

Because MM1 and MM7 use HTTP, the oversize limits for HTTP and the HTTP antivirus port configurations also apply to MM1 and MM7 scanning. See

MM3 and MM4 use SMTP and the oversize limits for SMTP and the SMTP antivirus port configurations also apply to MM3 and MM4 scanning.

The message contents will be scanned for viruses, matched against the file extension blocking lists and scanned for banned words. All these items will be configured via the standard GUI interfaces available for the other protocols and will be controlled at the protection profile level with new options specifically for the MM1 messages.

The FortiOS Carrier unit extracts the sender's Mobile Subscriber Integrated Services Digital Network Number (MSISDN) from the HTTP headers if available. The `POST` payload will be sent to the scan units which will parse the MMS content and scan each message data section. If any part of the data is to be blocked, the proxy will be informed, the connection to the MMSC will be reset and the Carrier-enabled FortiGate unit will return an `HTTP 200 OK` message with an `m-send-conf` payload to the client to prevent a retry. Finally the appropriate logging, alert, and replacement message events will be triggered.

For client notification, the `x-mms-response-status` and `x-mms-response-text` fields can also be customized as required.

Scanning MM1 retrieval messages

To scan MM1 retrieval messages, expand **MMS Scanning** and select **Scan MM1 message retrieval**.

Select to scan message retrievals that use MM1. If you enable **Virus Scan** for all MMS interfaces, messages are also scanned while being sent. In this case, you can disable MM1 message retrieval scanning to improve performance.

Configuring MMS virus scanning

To configure MMS virus scanning, expand **MMS Scanning** and enable **Virus Scan**.

Once applied to a security policy, the MMS protection profile will then perform virus scans on all traffic accepted by that policy.

Removing or replacing blocked messages

To remove blocked messages, expand **MMS Scanning** and select **Remove Blocked** for the selected MMS types.

Select **Remove Blocked** remove blocked content from each protocol and replace it with the replacement message. If FortiOS Carrier is to preserve the length of the message when removing blocked content, as may occur when billing is affected by the length of the message, select **Constant**.

If you only want to monitor blocked content, select **Monitor Only**.

Carrier Endpoint Block

A carrier endpoint defines a specific client on the carrier network. Typically the client IP address is used to identify the client, however on a carrier network this may be impractical when the client is using a mobile device. Other identifying information such as the MSIDSN number is used instead.

This information can be used to block a specific endpoint on the network. Reasons for blocking may include clients whose accounts have expired, clients from another carrier, clients who have sent malicious content (phishing, exploits, viruses, etc), or other violations of terms of use.

Enabling carrier endpoint blocking

To enable carrier endpoint blocking you first need to create a carrier endpoint filter list, and then enable it.

To enable carrier endpoint blocking - web-based manager

1. Create a carrier endpoint filter list.
2. Go to **Security Profiles > MMS Profile**.
3. Select **Create New**, or select an existing profile to edit and select **Edit**.
4. Expand MMS Scanning.
5. Select one or more types of MMS messaging to enable endpoint blocking on.
6. Select the carrier endpoint filter list to use in matching the endpoints to be blocked.

In MMS Profile, endpoints can only be blocked.

Create a carrier endpoint filter list

A carrier endpoint filter list contains one or more carrier endpoints to match. When used in MMS scanning entries in the filter list that are matched are blocked.

You can configure multiple filter lists for different purposes and groups of clients, such as blocking clients, clients with different levels of service agreements, and clients from other carriers. See Carrier endpoint filter lists configuration settings.

To create a carrier endpoint filter list - web-based manager

1. Go to **Security Profiles > Carrier Endpoint Filter Lists**.
2. Select **Create New**.
3. Enter a descriptive name for the filter list, such as `blocked_clients` or `CountryX_clients`, and select **OK**.
4. Select **Create New** to add one or more entries to the list.
5. Select **OK** to return to display the list of filter lists.

Configuring endpoint filter list entries

For each single endpoint or group of endpoints have part of their identifying information in common, you create an entry in the endpoint filter list.

For example a `blocked_clients` filter list may include entries for single endpoints added as each one needs to be blocked and a group of clients from a country that does not allow certain services.

To configure an endpoint filter list entry - web-based manager

1. Select **Create New**.
2. Enter the following information and select **OK**.

Name	Name of endpoint filter list. Select this name in an MMS protection profile.
Comments	Optional description of the endpoint filter list.
Check/Uncheck All	Select the check box to enable all endpoint patterns in the MMS filter list. Clear the check box to disable all entries on the MMS filter list. You can also select or clear individual check boxes to enable or disable individual endpoint patterns.
Pattern	The pattern that FortiOS Carrier uses to match with endpoints. The pattern can be a single endpoint or consist of wildcards or Perl regular expressions that will match more than one endpoint. For more on wildcard and regular expressions, see Using wildcards and Perl regular expressions in the UTM guide.

Action	Select the action taken by FortiOS Carrier for messages from a carrier endpoint that matches the endpoint pattern: **None** - No action is taken. **Block** - MMS messages from the endpoint are not delivered and FortiOS Carrier records a log message. **Exempt from mass MMS** - MMS messages from the endpoint are delivered and are exempt from mass MMS filtering. Mass MMS filtering is configured in MMS protection profiles and is also called MMS Bulk Email Filtering and includes MMS message flood protection and MMS duplicate message detection. A valid use of mass MMS would be when a service provider notifies customers of a system-wide event such as a shutdown. **Exempt from all scanning** - MMS messages from the endpoint are delivered and are exempt from all MMS protection profile scanning.
Content Archive	MMS messages from the endpoint are delivered, the message content is DLP archived according to MMS DLP archive settings. Content archiving is also called DLP archiving.
Intercept	MMS messages from the endpoint are delivered. Based on the quarantine configuration, attached files may be removed and quarantined.
Pattern Type	The pattern type: **Wildcard**, **Regular Expression**, or **Single Endpoint**.
Enable	Select to enable this endpoint filter pattern.

Blocking network access based on endpoints

You can use endpoint IP filtering to block traffic from source IP addresses associated with endpoints. You can also configure FortiOS Carrier to record log messages whenever endpoint IP filtering blocks traffic. Endpoint IP filtering blocks traffic at the IP level, before the traffic is accepted by a security policy.

To configure endpoint IP filtering, go to **Security Profiles > IP Filter** and add endpoints to the IP filter list. For each endpoint you can enable or disable both blocking traffic and logging blocked traffic.

You cannot add endpoint patterns to the endpoint IP filter list. You must enter complete and specific endpoints that are valid for your network.

The only action available is block. You cannot use endpoint IP filtering to exempt endpoints from IP filtering or to content archive or quarantine communication sessions.

FortiOS Carrier looks in the current user context list for the endpoints in the IP filter list and extracts the source IP addresses for these endpoints. Then any communication session with a source IP address that matches one of these IP addresses is blocked at the IP level, before the communication session is accepted by a security policy.

FortiOS Carrier dynamically updates the list of IP addresses to block as the user context list changes. Only these updated IP addresses are blocked by endpoint IP filtering.

For information about the carrier endpoints and the user context list, including how entries are added to and removed from this list.

MMS Content Checksum

The MMS content checksum feature attempts to match checksums of known malicious MMS messages, and on a successful match it will be blocked. The checksums are applied to each part of the message—attached files and message body have separate checksums. These checksums are created with CRC-32, the same method as FortiAnalyzer checksums.

For example, if an MMS message contains a browser exploit in the message body, you can add the checksum for that message body to the list, and future occurrences of that exact message will be blocked. Content will be replaced by the content checksum block notification replacement message for that type of MMS message, and if it is enabled the event will be logged.

One possible implementation would to configure all .sis files to be intercepted. When one is found to be infected or malicious it would be added to the MMS content checksum list.

To use this feature a list of one or more malicious checksums must be created and then the feature is enabled using that list. For a detailed list of options, see MMS Content Checksum.

To configure an MMS content checksum list

1. Go to **Security Profiles > MMS Content Checksum**.
2. Select **Create New**.
3. Enter a name for the list of checksums, and select **OK**.
   You are taken to the edit screen for that new list.
4. Select ***Create New*** to add a checksum.
5. Enter the ***Name*** and ***Checksum***, and select **OK**.
   The checksum is added to the list.

To add more checksums to the list, repeat steps 4 and 5.

To remove a checksum from the list you can either delete the checksum or simply disable it and leave it in the list.

To enable MMS content checksums, expand **MMS Scanning** and select **MMS Content Checksum** for the selected MMS types. Select the checksum list to match.

Passing or blocking fragmented messages

Select to pass fragmented MM3 and MM4 messages. Fragmented MMS messages cannot be scanned for viruses. If you do not select these options, fragmented MM3 and MM4 message are blocked.

The Interval is the time in seconds before client comforting starts after the download has begun, and the time between sending subsequent data.

The **Amount** is the number of bytes sent by client or server comforting at each interval.

Client comforting

In general, client comting is available for for MM1 and MM7 messaging and provides a visual display of progress for web page loading or HTTP or FTP file downloads. Client comforting does this by sending the first few packets of the file or web page being downloaded to the client at configured time intervals so that the client is not aware that the download has been delayed. The client is the web browser or FTP client. Without client comforting, clients and their users have no indication that the download has started until the Carrier-enabled FortiGate unit has completely buffered and scanned the download. During this delay users may cancel or repeatedly retry the transfer, thinking it has failed.

The appearance of a client comforting message (for example, a progress bar) is client-dependent. In some instances, there will be no visual client comforting cue.

During client comforting, if the file being downloaded is found to be infected, then the Carrier-enabled FortiGate unit caches the URL and drops the connection. The client does not receive any notification of what happened because the download to the client had already started. Instead the download stops, and the user is left with a partially downloaded file.

If the user tries to download the same file again within a short period of time, then the cached URL is matched and the download is blocked. The client receives the Infection cache message replacement message as a notification that the download has been blocked. The number of URLs in the cache is limited by the size of the cache.

Client comforting can send unscanned (and therefore potentially infected) content to the client. Only enable client comforting if you are prepared to accept this risk. Keeping the client comforting interval high and the amount low will reduce the amount of potentially infected data that is downloaded.

MM1 and MM7 client comforting steps

Since MM1 and MM7 messages use HTTP, MM1 and MM7 client comforting operates like HTTP client comforting.

The following steps show how client comforting works for a download of a 1 Mbyte file with the client comforting interval set to 20 seconds and the client comforting amount set to 512 bytes.

1. The client requests the file.
2. The Carrier-enabled FortiGate unit buffers the file from the server. The connection is slow, so after 20 seconds about one half of the file has been buffered.
3. The Carrier-enabled FortiGate unit continues buffering the file from the server, and also sends 512 bytes to the client.
4. After 20 more seconds, the FortiGate unit sends the next 512 bytes of the buffered file to the client.
5. When the file has been completely buffered, the client has received the following amount of data:

   ```
   ca * (T/ci) bytes == 512 * (40/20) == 512 * 2 == 1024 bytes,
   ```

   where `ca` is the client comforting amount, `T` is the buffering time and `ci` is the client comforting interval.
6. If the file does not contain a virus, the Carrier-enabled FortiGate unit sends the rest of the file to the client. If the file is infected, the FortiGate closes the data connection but cannot send a message to the client.

Server comforting

Server comforting can be selected for each protocol.

Similar to client comforting, you can use server comforting to prevent server connection timeouts that can occur while waiting for FortiOS Carrier to buffer and scan large `POST` requests from slow clients.

The **Interval** is the time in seconds before client and server comforting starts after the download has begun, and the time between sending subsequent data.

The **Amount** is the number of bytes sent by client or server comforting at each interval.

Handling oversized MMS messages

Select **Block** or **Pass** for files and email messages exceeding configured thresholds for each protocol.

The oversize threshold refers to the final size of the message, including attachments, after encoding by the client. Clients can use a variety of encoding types; some result in larger file sizes than the original attachment. As a result, a file may be blocked or logged as oversized even if the attachment is several megabytes smaller than the oversize threshold.

MM1 sample messages

```
Internet Protocol, Src Addr: 10.128.206.202 (10.128.206.202), Dst Addr: 10.129.192.190
    (10.129.192.190)
Transmission Control Protocol, Src Port: 34322 (34322), Dst Port: http (80), Seq: 1, Ack:
    1, Len: 1380
   Source port: 34322 (34322)
   Destination port: http (80)
   Header length: 20 bytes
   Flags: 0x0010 (ACK)
   Window size: 24840
   Checksum: 0x63c1 (correct)
```

HTTP proxy

```
Hypertext Transfer Protocol
   POST / HTTP/1.1\r\n
      Request Method: POST
      Request URI: /
      Request Version: HTTP/1.1
   Host: 10.129.192.190\r\n
   Accept: */*, application/vnd.wap.sic,application/vnd.wap.mms-message,text/x-
       hdml,image/mng,image/x-mng,video/mng,video/x-mng,image/bmp\r\n
   Accept-Charset: utf-8,*\r\n
   Accept-Language: en\r\n
   Content-Length: 25902\r\n
   Content-Type: application/vnd.wap.mms-message\r\n
   User-Agent: Nokia7650/1.0 SymbianOS/6.1 Series60/0.9 Profile/MIDP-1.0
       Configuration/CLDC-1.0 UP.Link/6.2.1\r\n
   x-up-devcap-charset: utf-8\r\n
   x-up-devcap-max-pdu: 102400\r\n
   x-up-uplink: magh-ip.mi.vas.omnitel.it\r\n
   x-wap-profile: "http://nds.nokia.com/uaprof/N7650r200.xml"\r\n
   x-up-subno: 1046428312-826\r\n
   x-up-calling-line-id: 393475171234\r\n
   x-up-forwarded-for: 10.211.4.12\r\n
   x-forwarded-for: 10.211.4.12\r\n
   Via: 1.1 magh-ip.mi.vas.omnitel.it\r\n
   \r\n
```

Scan engine

```
MMS Message Encapsulation, Type: m-send-req
   X-Mms-Message-Type: m-send-req (0x80)
   X-Mms-Transaction-ID: 1458481935
   X-Mms-MMS-Version: 1.0
   From: <insert address>
   To: 3475171234/TYPE=PLMN
   X-Mms-Message-Class: Personal (0x80)
   X-Mms-Expiry: 21600.000000000 seconds
   X-Mms-Priority: Normal (0x81)
   X-Mms-Delivery-Report: No (0x81)
   X-Mms-Read-Report: No (0x81)
   Content-Type: application/vnd.wap.multipart.related; start=<1822989907>;
       type=application/smil
      Start: <1822989907>
      Type: application/smil
   Data (Post)
      Multipart body
         Part: 1, content-type: text/plain
            Content-Type: text/plain; charset=iso-10646-ucs-2; name=Ciao.txt
               Charset: iso-10646-ucs-2
               Name: Ciao.txt
            Headers
               Content-Location: Ciao.txt
            Line-based text data: text/plain
               \377\376C\000i\000a\000o\000
[Unreassembled Packet: MMSE]
```

Sender notifications and logging

In most cases you will notify the sender that they are causing problems on the network — either by sending malware content, flooding the network, or some other unwanted activity. The notification assumes the sender is unaware of their activity and will stop or correct it when notified.

However, senders who are notified may use this information to circumvent administration's precautions. For example if flood notification is set to 1000 messages per minute, a notified user may simply reduce their message to 990 messages per minute if this flood is intentional. For this reason, not all problems include sender notifications.

There are two methods of notifying senders:

- MMS notifications
- Replacement messages

And three details to consider for logging and notifying administrators:

- Logging and reporting
- MMS logging options
- SNMP

MMS notifications

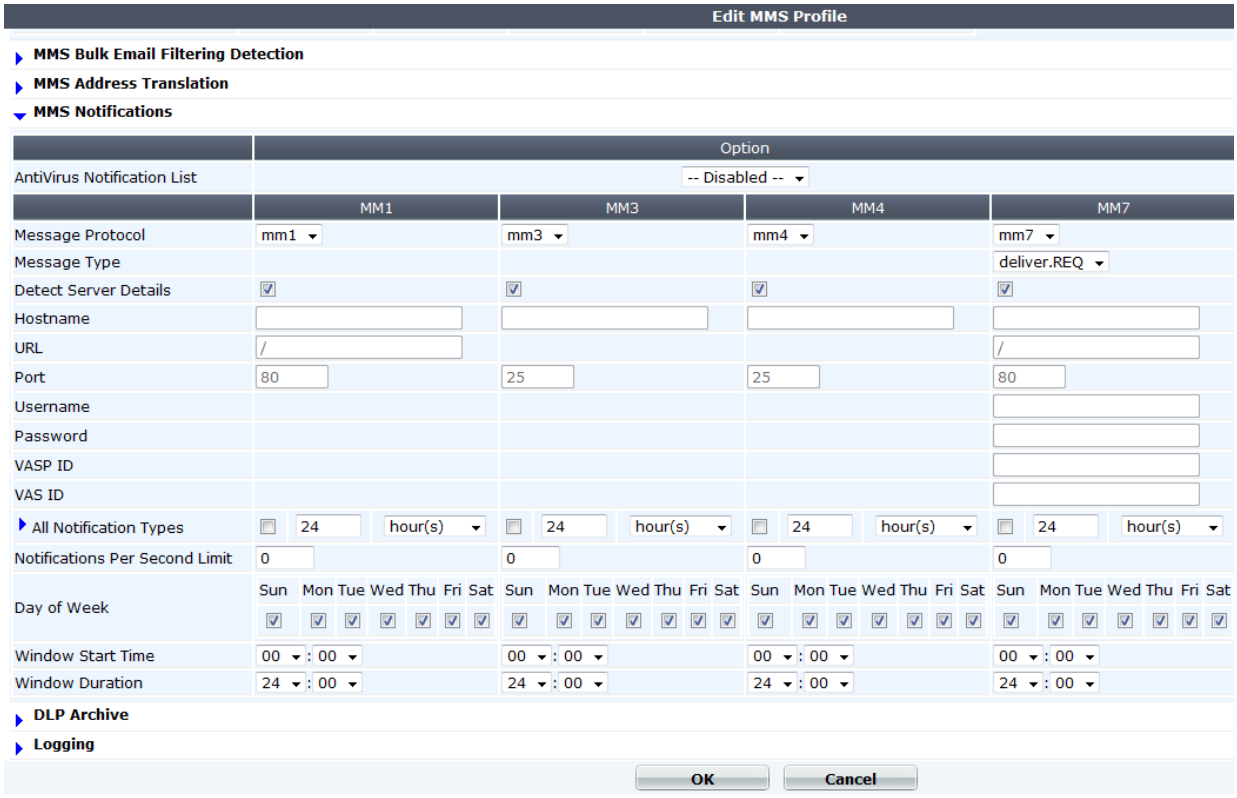
MMS notifications enable you to customize notifications for many different situations and differently for all the supported MMS message protocols — MM1, MM3, MM4, and MM7.

MMS notification types include:

- Content Filter
- File Block
- Carrier Endpoint Block
- Flood
- Duplicate
- MMS Content Checksum
- Virus Scan

Day of Week, **Window start time** and **Window Duration** define what days and what time of day alert notifications will be sent. This allows you to control what alerts are sent on weekends. It also lets you control when to start sending notifications each day. This can be useful if system maintenance is performed at the same time each night — you might want to start alert notifications after maintenance has completed. Another reason to limit the time alert messages are sent could be to limit message traffic to business hours.

Notifications screen for FortiOS Carrier MMS Profile



For MMS Notification options, see MMS Notifications.

Replacement messages

FortiGate units send replacement messages when messages or content is blocked, quarantined, or otherwise diverted from the receiver. In it's place a message is sent to notify the receiver what happened.

With FortiOS Carrier MMS replacement messages, send and receive message types are supported separately and receive their own custom replacement messages. This allows the network to potentially notify both the sender and receiver of the problem.

For example the replacement message **MM1 send-req file block message** is sent to the device that sent one or more files that were banned. The default message that is sent is `This device has sent %%NUM_MSG%% messages containing banned files in the last %%DURATION%% hours.` The two variables are replaced by the appropriate values.

Replacement messages are not as detailed or specific as MMS notifications, but they are also not as complicated to configure. They are also useful when content has been removed from an MMS message that was still delivered.

Logging and reporting

With each virus infection, or file block, a syslog message is generated. The format of this syslog message is similar to:

```
2005-09-22 19:15:47 deviceid=FGT5001ABCDEF1234 logid=0211060ABC type=virus
    subtype=infected level=warning src=10.1.2.3 dst=10.2.3.4 srcintf=port1 dstintf=port2
    service=mm1 status=blocked from="<sending MSISDN>" to="<receiving MSISDN>"
    file="eicar.com.txt" virus="EICAR_TEST_FILE" msg="The file eicar.com.txt is infected
    with EICAR_TEST_FILE. ref
    http://www.fortinet.com/VirusEncyclopedia/search/encyclopediaSearch.do?method=quickSea
    rchDirectly&virusName=EICAR_TEST_FILE"
```

Note that the **from** and **to** fields are samples and not real values.

MMS logging options

You can enable logging in an MMS protection profile to write event log messages when the MMS protection profile options that you have enabled perform an action. For example, if you enable MMS antivirus protection, you could also use the MMS protection profile logging options to write an event log message every time a virus is detected.

To record these log messages you must first configure how the FortiOS Carrier unit stores log messages.

To configure MMS content archiving, go to **Security Profiles > MMS Profile**. Select **Create New** or select the **Edit** icon beside an existing profile. Expand **MMS Bulk AntiSpam Detection > Logging**. Complete the fields as described in the following table and select **OK**. For more a detailed list of options, see Logging.

SNMP

A simple SNMP trap will be generated to inform the operators' alerting system that a virus has been detected. This SNMP trap could contain the sending and receiving MSISDN, however the initial solution would reflect the current behavior, i.e. only the fact that a virus has been detected will be communicated.

MMS content-based Antispam protection

Expand **MMS Scanning** and select **Content Filter** in an MMS protection profile to create content filter black/white lists that block or allow MMS messages based on the content of the message.

Overview

A school computer lab may block age-inappropriate content. A place of business may block unproductive content. A public access internet cafe may block offensive and graphic content. Each installation has its own requirements for what content needs to be blocked, and in what language.

FortiOS Carrier provides the ability to create custom local dictionaries, black lists, and white lists in multiple languages enables you to protect your customers from malicious content around the world.

Configurable dictionary

You can create a dictionary of configurable terms and phrases using the CLI. The text of MMS messages will be searched for these terms and phrases. Add content filter lists that contain content that you want to match in MMS messages. For every match found, a score is added. If enough matches are found to set the total score above the configured threshold, the MMS message is blocked.

You can add words, phrases, wild cards and Perl regular expressions to create content patterns that match content in MMS messages. For more on wildcard and regular expressions, see Using wildcards and Perl regular expressions in the UTM guide.

For each pattern you can select **Block** or **Exempt**.

- Block adds an antispam black list pattern. A match with a block pattern blocks a message depending on the score of the pattern and the content filter threshold.
- Exempt adds an antispam white list pattern. A match with an exempt pattern allows the message to proceed through the FortiOS Carrier unit, even if other content patterns in the same content filter list would block it.

If a pattern contains a single word, the FortiOS Carrier unit searches for the word in MMS messages. If the pattern contains a phrase, the FortiOS Carrier unit searches for all of the words in the phrase. If the pattern contains a phrase in quotation marks, the FortiOS Carrier unit searches for the whole phrase.

You can create patterns with Simplified Chinese, Traditional Chinese, Cyrillic, French, Japanese, Korean, Spanish, Thai, or Western character sets.

Black listing

Black listing is the practice of banning entries on the list. For example if an IP address continuously sends viruses, it may be added to the black list. That means any computers that consult that list will not communicate with that IP address.

Sometimes computers or devices can be added to black lists for a temporary problem, such as a virus that is removed when notified. However, as a rule short of contacting the administrator in person to manually be removed form the black list, users have to wait and they generally will be removed after a period without problem.

White listing

White listing is the practice of adding all critical IP addresses to a list, such as company email and web servers. Then if those servers become infected and start sending spam or viruses, those servers are not blocked. This allows the critical traffic through, even if there might be some malicious traffic as well. Blocking all traffic from your company servers would halt company productivity.

Scores and thresholds

Each content pattern includes a score. When a MMS message is matched with a pattern the score is recorded. If a message matches more than one pattern or matches the same pattern more than once, the score for the message increases. When the total score for a message equals or exceeds the threshold the message is blocked.

The default score for a content filter list entry is 10 and the default threshold is 10. This means that by default a message is blocked by a single match. You can change the scores and threshold so that messages can only be blocked if there are multiple matches. For example, you may only want to block messages that contain the phrase “example” if it appears twice. To do this, add the “example” pattern, set action to block and score to 5. Keep the threshold at 10. If “example” is found twice or more in a message the score adds up 10 (or more) and the message is blocked.

Configuring content-based antispam protection

To apply content-based antispam protection - CLI

```
config webfilter content
   edit <filter_table_number>
      set name <filter_table_name>
      config entries
         edit <phrase or regexp you want to block>
            set action {block | exempt}
            set lang <phrase language>
            set pattern-type {wildcard | regexp}
            set score <phrase score>
            set status {enable | disable}
         end
      end
```

Configuring sender notifications

When someone on the MMS network sends an MMS message that is blocked, in most cases you will notify the sender. Typically an administrator is notified in addition to the sender so action can be taken if required. There are two types of sender notifications available in FortiOS Carrier: MMS notifications, and Replacement Messages.

MMS notifications

MMS notifications to senders are configured in **Security Profiles > MMS Profile**, under MMS Notifications.

In this section you can configure up to four different notification recipients for any combination of MM1/3/4/7 protocol MMS messages. Also for MM7 messages the message type can be `submit.REQ` or `deliver.REQ`.

Useful settings include:

- delay in message based on notification type
- limit on notifications per second to prevent a flood
- schedules for notifications
- log in details for MM7 messages.

For more information on MMS notifications, see Notifying message flood senders and receivers and MMS Notifications.

Replacement messages

Replacement messages are features common to both FortiOS and FortiOS Carrier, however FortiOS Carrier has additional messages for the MMS traffic.

While each MMS protocol has its own different rec placement messages, the one common to all MMS protocols is the **MMS blocked content replacement message**. This is the message that the receiver of the message sees when their content is blocked.

MMS DLP archiving

You can use DLP archiving to collect and view historical logs that have been archived to a FortiAnalyzer unit or the FortiGuard Analysis and Management service. DLP archiving is available for FortiAnalyzer when you add a FortiAnalyzer unit to the FortiOS Carrier configuration. The FortiGuard Analysis and Management server becomes available when you subscribe to the FortiGuard Analysis and Management Service.

You can configure full DLP archiving and summary DLP archiving. Full DLP archiving includes all content, for example, full email DLP archiving includes complete email messages and attachments. Summary DLP archiving includes just the meta data about the content, for example, email message summary records include only the email header.

You can archive MM1, MM3, MM4, and MM7 content.

Configuring MMS DLP archiving

Select DLP archive options to archive MM1, MM3, MM4, and MM7 sessions. For each protocol you can archive just session metadata (**Summary**), or metadata and a copy of the associated file or message (**Full**).

In addition to MMS protection profile DLP archive options you can:

- Archive MM1 and MM7 message floods
- Archive MM1 and MM7 duplicate messages
- Select **DLP archiving** for carrier endpoint patterns in a **Carrier Endpoint List** and select the **Carrier Endpoint Block** option in the **MMS Scanning** section of an MMS Protection Profile

FortiOS Carrier only allows one sixteenth of its memory for transferring content archive files. For example, for Carrier-enabled FortiGate units with 128 MB RAM, only 8 MB of memory is used when transferring content archive files. Best practices dictate to not enable full content archiving if antivirus scanning is also configured because of these memory constraints.

To configure MMS DLP archiving - web-based manager

1. Go to **Security Profiles > MMS Profile**.
2. Select **Create New** or select the **Edit** icon beside an existing profile.
3. Expand **MMS Bulk AntiSpam Detection > Content Archive**.
4. Complete the fields as described in DLP Archive options.
5. Select **OK**.

Viewing DLP archives

You can view DLP archives from the Carrier-enabled FortiGate unit web-based manager. Archives are historical logs that are stored on a log device that supports archiving, such as a FortiAnalyzer unit.

These logs are accessed from either **Log & Report > DLP Archive** or if you subscribed to the FortiCloud service, you can view log archives from there.

The **DLP Archive** menu is only visible if one of the following is true.

- You have configured the FortiGate unit for remote logging and archiving to a FortiAnalyzer unit.
- You have subscribed to FortiCloud.

The following tabs are available when you are viewing DLP archives for one of these protocols.

- **E-mail** to view POP3, IMAP, SMTP, POP3S, IMAPS, SMTPS, and spam email archives.
- **Web** to view HTTP and HTTPS archives.
- **FTP** to view FTP archives.
- **IM** to view AIM, ICQ, MSN, and Yahoo! archives.
- **MMS** to view MMS archives.
- **VoIP** to view session control (SIP, SIMPLE and SCCP) archives.

If you need to view log archives in Raw format, select **Raw** beside the **Column Settings** icon.

GTP basic concepts

GPRS currently supports data rates from 9.6 kbps to more than 100 kbps, and is best suited for burst forms of traffic. GPRS involves both radio and wired components. The mobile phone sends the message to a base station unit (radio based), and the base station unit sends the message to the carrier network and eventually the Internet (wired carrier network).

The network system then either sends the message back to a base station and to the destination mobile unit, or forwards the message to the proper carrier's network where it gets routed to the mobile unit.

PDP Context

The packet data protocol (PDP) context is a connection between a mobile station and the end address that goes through the SGSN and GGSN. It includes identifying information about the mobile customer used by each server or device to properly forward the call data to the next hop in the carrier network, typically using a GTP tunnel between the SGSN and GGSN.

When a mobile customer has an active voice or data connection open, both the SGSN and GGSN have the PDP context information for that customer and session.

When a mobile phone attempts to communicate with an address on an external packet network, either an IP or X.25 address, the mobile station that phone is connected to opens a PDP context through the SGSN and GGSN to the end address. Before any traffic is sent, the PDP context must first be activated.

The information included in the PDP context includes the customer's IP address, the IMSI number of the mobile handset, and the tunnel endpoint ID for both the SGSN and GGSN. The ID is a unique number, much like a session ID on a TCP/IP firewall. All this information ensures a uniquely identifiable connection is made.

Since one mobile device may have multiple connections open at one time, such as data connections to different Internet services and voice connections to different locations, there may be more than one PDP context with the same IP address making the extra identifying information required.

The endpoint that the mobile phone is connecting to only knows about the GGSN — the rest of the GPRS connection is masked by the GGSN.

Along the PDP context path, communication is accomplished in using three different protocols.

- The connection between the Mobile Station and SGSN uses the SM protocol.
- Between SGSN and GGSN GTP is used.
- Between GGSN and the endpoint either IP or X.25 is used.

FortiOS Carrier is concerned with the SGSN to GGSN part of the PDP context — the part that uses GTP.

For more about PDP context, see Tunnel Management Messages.

Creating a PDP context

While FortiOS Carrier is concerned mostly with the SGSN to GGSN part of the PDP Context, knowing the steps involved in creating a PDP context helps understand the role each device, protocol, and message type plays.

Both mobile stations and GGSNs can create PDP contexts.

A Mobile Station creates a PDP context

1. The Mobile Station (MS) sends a `PDP activation request` message to the SGSN including the MS PDP address, and APN.
2. Optionally, security functions may be performed to authenticate the MS.
3. The SGSN determines the GGSN address by using the APN identifier.
4. The SGSN creates a down link GTP tunnel to send IP packets between the GGSN and SGSN.
5. The GGSN creates an entry in its PDP context table to deliver IP packets between the SGSN and the external packet switching network.
6. The GGSN creates an uplink GTP tunnel to route IP-PDU from SGSN to GGSN.
7. The GGSN then sends back to the SGSN the result of the PDP context creation and if necessary the MS PDP address.
8. The SGSN sends an `Activate PDP context accept` message to the MS by returning negotiated the PDP context information and if necessary the MS PDP address.
9. Now traffic can pass from the MS to the external network endpoint.

A GGSN creates a PDP context

1. The network receives an IP packet from an external network.
2. The GGSN checks if the PDP Context has already been created.
3. If not, the GGSN sends a `PDU notification request` to the SGSN in order to initiate a PDP context activation.
4. The GGSN retrieves the IP address of the appropriate SGSN address by interrogating the HLR from the IMSI identifier of the MS.
5. The SGSN sends to the MS a request to activate the indicated PDP context.
6. The PDP context activation procedure follows the one initiated by the MS. See "A Mobile Station creates a PDP context".
7. When the PDP context is activated, the IP packet can be sent from the GGSN to the MS.

Terminating a PDP context

A PDP context remains open until it is terminated. To terminate the PDP context an MS sends a `Deactivate PDP context` message to the SGSN, which then sends a `Delete PDP Context` message to the GGSN. When the SGSN receives a PDP context deletion acknowledgment from the GGSN, the SGSN confirms to the MS the PDP context deactivation. The PDP can be terminated by the SGSN or GGSN as well with a slight variation of the order of the messages passed.

When the PDP Context is terminated, the tunnel it was using is deleted as well. If this is not completed in a timely manner, it is possible for someone else to start using the tunnel before it is deleted. This hijacking will result in the original customer being over billed for the extra usage. Anti-overbilling helps prevent this. See Configuring Anti-overbilling in FortiOS Carrier.

GPRS security

The GPRS network has some built-in security in the form of GPRS authentication. However this is minimal, and is not sufficient for carrier network security needs. A GTP firewall, such as FortiOS Carrier, is required to secure the Gi, Gn, and Gp interfaces.

GPRS authentication

GPRS authentication is handled by the SGSN to prevent unauthorized GPRS calls from reaching the GSM network beyond the SGSN (the base station system, and mobile station). Authentication is accomplished using some of the customer's information with a random number and uses two algorithms to create ciphers that then allow authentication for that customer.

User identity confidentiality ensures that customer information stays between the mobile station and the SGSN — no identifying information goes past the SGSN. Past that point other numbers are used to identify the customer and their connection on the network.

Periodically the SGSN may request identity information from the mobile station to compare to what is on record, using the IMEI number.

Call confidentiality is achieved through the use of a cipher, similar to the GPRS authentication described earlier. The cipher is applied between the mobile station and the SGSN. Essentially a cipher mask is XORd with each outgoing frame, and the receiving side XORs with its own cipher to result in the original frame and data.

Parts of a GTPv1 network

A sample GTP network consists of the end handset sender, the sender's mobile station, the carrier's network including the SGSN and GGSN, the receiver's mobile station, and the receiver handset.

When a handset moves from one mobile station and SGSN to another, the handset's connection to the Internet is preserved because the tunnel the handset has to the Internet using GTP tracks the user's location and information. For example, the handset could move from one cell to another, or between countries.

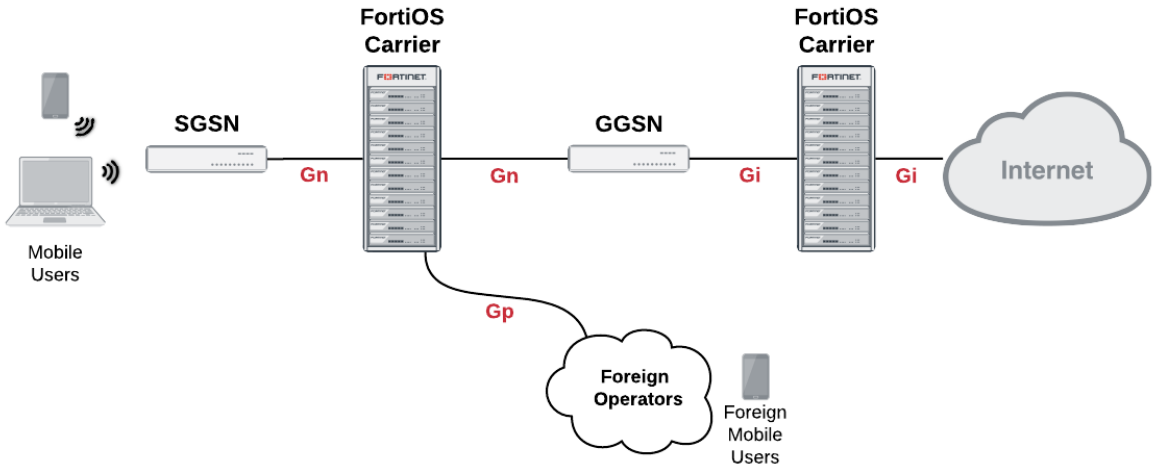
The parts of a GPRS network can be separated into the following groups according to the roles of the devices:

- Radio access to the GPRS network is accomplished by mobile phones and mobile stations (MS).
- Transport the GPRS packets across the GPRS network is accomplished by SGSNs and GGSNs, both local and remote, by delivering packets to the external services.
- Billing and records are handled by CDF, CFR, HLR, and VLR devices.

GPRS networks also rely on access points and PDP contexts as central parts of the communication structure. These are not actual devices, but they are still critical .

These devices, their roles, neighboring devices, the interfaces and protocols they use are outlined in the following table.

Carrier network showing the interfaces used (GTPv1)



Devices on a GTPv1 network

Device role	Neighboring Devices	Interfaces used	Protocols used
Mobile Users	Mobile Stations (MS)	Radio Access Technology (RAT)	
Mobile Stations (MS)	Mobile Users, SGSN	Gb	IP, Frame Relay
SGSN (local)	MS, SGSN (local or remote), GGSN (local and remote), CDR, CFR, HLR, VLR	Ga, Gb, Gn, Gp, Gz	IP, Frame Relay, GTP, GTP'
SGSN (remote)	SGSN (local)	Gn	GTP
GGSN (local)	SGSN (local or remote), GGSN (local and remote), CDR, CFR, HLR, VLR	Ga, Gi, Gn, Gp, Gz	IP, GTP, GTP'
GGSN (remote)	SGSN (local), WAP gateway, Internet, other external services	Gi, Gp	IP, GTPv1
CDR, CFR	SGSN (local), GGSN (local)	Ga, Gz	GTP'
HLR, VLR	SGSN (local), GGSN (local)	Ga, Gz	GTP'

Radio access

For a mobile phone to access the GPRS core network, it must first connect to a mobile station. This is a cellular tower that is connected to the carrier network.

How the mobile phone connects to the mobile station (MS) is determined by what Radio Access Technologies (RATs) are supported by the MS.

Transport

Transport protocols move data along the carrier network between radio access and the Internet or other carrier networks.

FortiOS Carrier should be present where information enters the Carrier network, to ensure the information entering is correct and not malicious. This means a Carrier-enabled FortiGate unit intercepts the data coming from the SGSN or foreign networks destined for the SSGN or GGSN onto the network, and after the GGSN as the data is leaving the network.

GTP

GPRS Tunnelling Protocol (GTP) is a group of IP-based communications protocols used to carry General Packet Radio Service (GPRS) within Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications System (UMTS) networks. It allows carriers to transport actual cellular packets over a network via tunneling. This tunneling allows users to move between SGSNs and still maintain connection to the Internet through the GGSN.

GTP has three versions version 0, 1, and 2. GTP1 and GTP2 are supported by FortiOS Carrier. The only GTP commands that are common to all forms of GTP are the echo request/response commands that allow GSNs to verify up to once every 60 seconds that neighboring GSNs are alive.

GTPv0

There have been three versions of GTP to date. The original version of GTP (version 0) has the following differences from version GTPv1.

- the tunnel identification is not random
- there are options for transporting X.25
- the fixed port number 3386 is used for all functions, not just charging
- optionally TCP is allowed as a transport instead of UDP
- not all message types are supported in version 0

GTPv1

On a GPRS network, Packet Data Protocol (PDP) context is a data structure used by both the Serving GPRS Support Node (SGSN) and the Gateway GPRS Support Node (GGSN). The PDP context contains the subscribers information including their access point, IP address, IMSI number, and their tunnel endpoint ID for each of the SGSN and GGSN.

The Serving GPRS Support Node (SGSN) is responsible for the delivery of data packets from and to the mobile stations within its geographical service area. Its tasks include packet routing and transfer, mobility management (attach/detach and location management), logical link management, and authentication and charging functions.

The location register of the SGSN stores location information (e.g., current cell, current VLR) and user profiles (e.g., IMSI, address(es) used in the packet data network) of all GPRS users registered with this SGSN.

GTPv1-C

GTPv1-C refers to the control layer of the GPRS Transmission network. This part of the protocol deals with network related traffic.

FortiOS Carrier handles GTPv1-C in GTPv1 by using the Tunnel Endpoint IDentifier (TEID), IP address and a Network layer Service Access Point Identifier (NSAPI), sometimes called the application identifier, as an integer value that is part of the PDP context header information used to identify a unique PDP context in a mobile station, and SGSN.

For more information on GTPv1-C, see GTP-C messages.

GTPv1-U

GTPv1-U is defined in 3GPP TS 29.281 and refers to the user layer of the GPRS Tunneling network. This part of the protocol deals with user related traffic, user tunnels, and user administration issues.

A GTPv1-U tunnel is identified by a TEID, an IP address, and a UDP port number. This information uniquely identifies the limb of a GTPv1 PDP context. The IP address and the UDP port number define a UDP/IP path, a connectionless path between two endpoints (i.e. SGSN or GGSN). The TEID identifies the tunnel endpoint in the receiving GTPv1-U protocol entity; it allows for the multiplexing and demultiplexing of GTP tunnels on a UDP/IP path between a given GSN-GSN pair. For more information on GTPv1-U, see GTP-U messages.

The GTP core network consists of one or more SGSNs and GGSNs.

GGSN

The Gateway GPRS Support Node (GGSN) connects the GPRS network on one side via the SGSN to outside networks such as the Internet. These outside networks are called packet data networks (PDNs). The GGSN acts as an edge router between the two different networks — the GGSN forwards incoming packets from the external PDN to the addressed SGSN and the GGSN also forwards outgoing packets to the external PDN. the GGSN also converts the packets from the GPRS packets with SGSN to the external packets, such as IP or X.25.

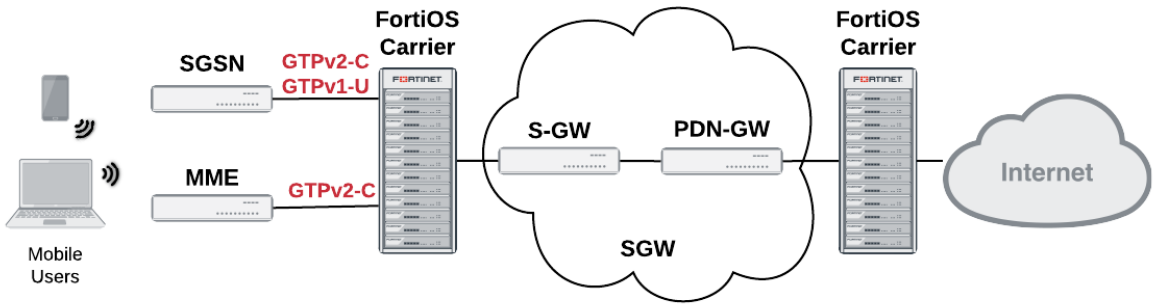
SGSN

The Serving GPRS Support Node (SGSN) connects the GPRS network to GTPv1 compatible mobile stations, and mobile units (such as UTRAN and ETRAN) on one side and to the gateway node (GGSN), which leads to external networks, on the other side. Each SGSN has a geographical area, and mobile phones in that area connect to the GPRS network through this SGSN. The SGSN also maintains a location register that contains customer's location and user profiles until they connect through a different SGSN at which time the customer information is moved to the new SGSN. This information is used for packet routing and transfer, mobility management also known as location management, logical link management, and authentication and billing functions.

GTPv2

GTPv2, defined in 3GPP TS 29.274, is dramatically different from GTPv1, defined in 3GPP TS 29.060. Where in GTPv1 the tunnel is between the SGSN and the GGSN, in GTPv2 The SGSN is between the MME and the LTE Serving Gateway (S-GW), beyond which is the PDN gateway (P-GW). Even tunnel management messages have changed significantly.

Network diagram for GTPv2



Device roles on a GTPv2 network

Device role	Neighboring Devices	Interfaces used	Protocols used
Mobile Users	Mobile Stations (MS)	Radio Access Technology (RAT)	--
GTPv1 Mobile Stations (MS)	Mobile Users, SGSN	Gb	IP, Frame Relay
GTPv2 Mobile Stations (MS)	Mobile Users, MME	???	IP, Frame Relay
SGSN (local)	GTPv1 MS, SGSN, S-GW	???	IP, Frame Relay, GTPv1, GTP'
S-GW	SGSN, MME, P-GW	???	IP, GTPv2, GTP'
P-GW	S-GW, Internet, other external services	???	IP, GTPv2

GTPv2-C

GTPv2-C is the control layer messaging for GTPv2. It is used by LTE mobile stations, SGSN units for backwards compatibility, and SGWs that are the gateway to other networks. The messaging is very different from GTPv1. GTPv2-C is required to communicate with the Mobility Management Entity (MME) to create, change and delete EPS bearers when handover events happen, and to create Forwarding tunnels. The protocol is also used to communicate with the Serving Gateway (SGW) which has the S-GW and PDN-GW interfaces, and the Serving GPRS Support Node (SGSN).

MME

MME essentially fills the role of the SGSN in a GTPv1 network — it is how the mobile stations gain access to the Carrier network. GTPv2 supports different mobile stations than GTPv1, so MME handles the GTPv2 MSes and SGSN handles the GTPv1 MSes

Billing and records

A major part of the GPRS network is devoted to billing. Customer billing requires enough information to identify the customer, and then billing specific information such as connection locations and times, as well as amount of data transferred. A modified form of GTP called GTP' is used for billing. The home location records and visitor location records store information about customers that is critical to billing.

GTP' (GTP prime)

GTP is used to handle tunnels of user traffic between SGSNs and GGSNs. However for billing purposes, other devices that are not supported by GTP are required. GTP' (GTP prime) is a modified form of GTP and is used to communicate with these devices such as the Charging Data Function (CDF) that communicates billing information to the Charging Gateway Function (CGF). In most cases, GTP' transports user records from many individual network elements, such as the GGSNs, to a centralism computer which then delivers the charging data more conveniently to the network operator's billing center, often through the CGF. The core network sends charging information to the CGF, typically including PDP context activation times and the quantity of data which the end user has transferred.

GTP' is used by the Ga and Gz interfaces to transfer billing information. GTP' uses registered UDP/TCP port 3386. GTP' defines a different header, additional messages, field values, as well as a synchronization protocol to avoid losing or duplicating CDRs on CGF or SGSN/GGSN failure. Transferred CDRs are encoded in ASN.1.

HLR

The Home Location Register (HLR) is a central database that contains details of each mobile phone subscriber that is authorized to use the GSM core network. There can be several logical, and physical, HLRs per public land mobile network (PLMN), though one international mobile subscriber identity (IMSI)/MSISDN pair can be associated with only one logical HLR (which can span several physical nodes) at a time. The HLRs store details of every SIM card issued by the mobile phone operator. Each SIM has a unique identifier called an IMSI which is the primary key to each HLR record.

VLR

The Visitor Location Register (VLR) is a database which stores information about all the mobile devices that are currently under the jurisdiction of the Mobile Switching Center which it serves. Of all the information the VLR stores about each Mobile Station, the most important is the current Location Area Identity (LAI). This information is vital in the call setup process.

Whenever an MSC detects a new MS in its network, in addition to creating a new record in the VLR, it also updates the HLR of the mobile subscriber, informing it of the new location of that MS.

For more information on GTP', see GTP-U and Charging Management Messages.

GPRS network common interfaces

There are interfaces for each connection on the GPRS network. An interface is an established standard form of communication between two devices. Consider a TCP/IP network. In addition to the transport protocol (TCP) there are other protocols on that network that describe how devices can expect communications to be organized, just like GPRS interfaces.

Interfaces between devices on the network

There are a series of interfaces that define how different devices on the carrier network communicate with each other. There interfaces are called Ga to Gz, and each one defines how a specific pair of devices will communicate. For example Gb is the interface between the base station and the SGSN, and Gn is one possible interface between the SGSN and GGSN.

The SGSN and GGSN keep track of the CDR information and forward it to the Charging Data Function (CDF) using the Gr interface between the SGSN and home location register (HLR), Gs interface between the SGSN and MSC (VLR), Gx interface between the GGSN and the Charging Rules Function (CRF), Gy between the GGSN and online charging system (OCS), and finally Gz which is the off-line (CDR-based) charging interface between the GSN and the CG that uses GTP'.

Each of these interfaces on the GPRS network is has a name in the format of `Gx` where `x` is a letter of the alphabet that determines what part of the network the interface is used in. It is common for network diagrams of GPRS networks to include the interface name on connections between devices.

The Carrier-enabled FortiGate unit only provides protection on the Gn, Gp, and Gi interfaces.

GPRS network interfaces, their roles, and billing

Name	Device connections that use this interface	Traffic Protocol used	Its role or how it affects billing
Ga	CDR and GSN (SGSNs and GGSNs)	GTP‘ - GTP modified to include CDR role	CDR have the accounting records, that are compiled in the GSN and then sent to the Charging Gateway (CG)
Gb	MS and SGSN	Frame Relay or IP	When an IP address moves to a new MS, the old MS may continue to use and bill that IP address.
Gi	GGSN and public data networks (PDNs)	IP based	This is the connection to the Internet. If the GTP tunnel is deleted without notifying the Gi interface, the connection may remain open incurring additional charges. FortiOS Carrier adds this interface to a firewall. See Anti-overbilling with FortiOS Carrier.
Gn	SGSN and external SGSNs and internal GGSNs	GTP	When the GTP tunnel is deleted, need to inform other interfaces immediately to prevent misuse of connections remaining open. FortiOS Carrier adds this interface to a firewall.
Gp	Internal SGSN and external GGSNs	GTP	
Gz	GSN (SGSN and GGSN) and the charging gateway (CG)	GTP‘	Used for the offline charging interface. Ga is used for online charging.

Corporate customers may have a direct connection to the Gi interface for higher security. The Gi interface is normally an IP network, though a tunnelling protocol such as GRE or IPsec may be used instead.

GTP Configuration

The GTP (GPRS Tunneling Protocol) is one of the major mobile core protocols used since to transfer data in the core mobile network. Mobility and data are exploding and this trend will continue with VoLTE, 5G, and the Internet of Things (IoT). The role of GTP in mobile networks will continue to remain critical.

With the mobile network ever growing importance as the communication channel for data rich application on mobile devices, connected intelligent devices and the IoT, comes the growing potential for attacks on the mobile infrastructure.

Introduction to GTP

GTP as a Potential Attack Vector

GTP's role in transferring data in the core mobile infrastructure makes it a potential ideal attack vector. To understand the security features for GTP we need to understand the risks that might compromise this protocol. The business impact might varies in-between the different attacks from Denial of Service (DoS) attacks that hinders the capability of performing a legitimate operation due to resource starvation (for example - not being able to charge the customer for GPRS traffic use due to denial of service attack on the Charging GW) to remote compromise attacks that allows the hacker to have remote control of a critical device (for example – take control over a GGSN).

GTP-based attacks may have a wide range of business impact, based on the attacked devices' vulnerability, ranging from service unavailability, compromise customer information, and gaining control over infrastructure elements, just to give a few examples.

Listed below are the main categories of GTP-based attacks:

- **Protocol anomaly attacks** are packets and packets formats that should not be expected on the GTP protocol. These can include malformed packets, reserved packets' fields and types, etc.
- **Infrastructure attacks** are attempts to connect to restricted core elements, such as the GGSN, SGSN, PGW, etc.
- **Overbilling attacks** results in customers charged for traffic they did not use or the opposite of not paying for the used traffic.

Protecting Against GTP-Based Attacks: The Carrier Grade GTP Firewall

With the evolution of the mobile network so has GTP evolved. The awareness to the potential of GTP-based attacks has led mobile core vendors to harden their software to better deal with a potential attack. Alongside this evolution, network security vendors, such as Fortinet, has led the way in providing specific GTP aware firewalls to secure and protect the different versions of the GTP protocol from potential attacks.

A GTP firewall should be placed where GTP traffic and session originate and terminate, as shown in the below diagram, and has to inspect both the GTP-C (Control Plane) and GTP-U (Data Plane) packets that, together, constitute the GPRS Tunneling Protocol.

The GTP firewall in both cases is placed in line between the SGSN / SGW and the GGSN / PGW which are the initiator and terminator of the GTP traffic. One of the main roles of GTP firewall is also to be able to support the roaming between different versions of GTP without interrupting the service.

The GTP firewall must be carrier grade in its ability to scale and provide high availability without impact its ability to provide effective protection.

FortiGate with FortiCarrier – The Leading GTP Firewall

FortiGate is Fortinet's physical security platform, built specifically for high performance and scalability with the utilization of specialized FortiASIC technology. Fortinet Content Processors (CP) and Network Processors (NP) enable, offloading CPU intensive tasks and allowing the FortiGate to provide carrier grade performance and scalability. Utilizing the power of the FortiGate platform, FortiOS, Fortinet's security Operating System, provides threat intelligence and advanced functionalities to provide effective security, ranging from Carrier Grade NAT (CGNAT), firewalling, IPSec, etc.

FortiCarrier is the part of FortiOS which was specifically designed to provide security for specific carriers and mobile operators' protocols and requirements, such as awareness and security for GTP. The wide range of FortiGate platforms with FortiOS and FortiCarrier enables mobile operators to cost effectively secure their mobile network against GTP-based attacks, while ensuring unparalleled performance, availability and security effectiveness.

GTP Profile

You can configure multiple GTP profiles within the GTP menu. GTP profiles concern GTP activity flowing through the unit. These GTP profiles are then applied to a security policy.

GTP profile configuration settings

The following are GTP profile configuration settings in **Security Profiles > GTP Profiles**.

GTP Profile	
Lists each GTP profile that you have created. On this page, you can edit, delete or create a new GTP profile.	
Create New	Creates a new GTP profile. When you select **Create New**, you are automatically redirected to the New page.
Edit	Modifies settings within a GTP profile in the list. When you select **Edit**, you are automatically redirected to Edit page.

Delete	Removes a GTP profile from the list. To remove multiple GTP profiles from within the list, on the GTP Profile page, in each of the rows of the profiles you want removed, select the check box and then select **Delete**. To remove all GTP profiles from within the list, on the GTP Profile page, select the check box in the check box column and then select **Delete**.
Name	The name of the GTP profile.
Ref.	Displays the number of times the object is referenced to other objects. For example, av_1 profile is applied to a security policy; on the Profile page (**Security Profiles > Antivirus > Profiles**), 1 appears in **Ref.** . To view the location of the referenced object, select the number in **Ref.**, and the Object Usage window appears displaying the various locations of the referenced object. To view more information about how the object is being used, use one of the following icons that is available within the Object Usage window: • **View the list page for these objects** – automatically redirects you to the list page where the object is referenced at. • **Edit this object** – modifies settings within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy and so, when this icon is selected, the user is redirected to the Edit Policy page. • **View the details for this object** – table, similar to the log viewer table, contains information about what settings are configured within that particular setting that the object is referenced with. For example, av_1 profile is referenced with a security policy, and that security policy's settings appear within the table.
New GTP Profile Provides settings for configuring a GTP profile.	
Name	Enter a name for the GTP profile.
General Settings	Configure general options for the GTP profile.
Message Type Filtering	Configure filtering for messages.
APN Filtering	Configure filtering options for APN.
Basic Filtering	Configure filtering options for IMSI.

Advanced Filtering	Configure advanced filtering options.
IE removal policy	Configure IE removal policy options.
Encapsulated IP Traffic Filtering	Configure filtering options for encapsulated IP traffic.
Encapsulated Non-IP End User Address Filtering	Configure filtering options for encapsulated non-IP end user addresses.
Protocol Anomaly	Configure protocol anomaly options.
Anti-Overbilling	Configure anti-overbilling options.
Log	Configure log options.

General settings options

The following are mostly house keeping options that appear in the General Settings area of the GTP configuration page.

General Settings section of the New GTP Profile	
GTP-in-GTP	Select **Allow** to enable GTP packets to be allowed to contain GTP packets, or a GTP tunnel inside another GTP tunnel. To block all GTP-in-GTP packets, select **Deny**.
Minimum Message Length	Enter the shortest possible message length in bytes. Normally this is controlled by the protocol, and will vary for different message types. If a packet is smaller than this limit, it is discarded as it is likely malformed and a potential security risk. The default minimum message length is 0 bytes.
Maximum Message Length	Enter the maximum allowed length of a GTP packet in bytes. A GTP packet contains three headers and corresponding parts GTP, UDP, and IP. If a packet is larger than the maximum transmission unit (MTU) size, it is fragmented to be delivered in multiple packets. This is inefficient, resource intensive, and may cause problems with some applications. By default the maximum message length is 1452 bytes.

General Settings section of the New GTP Profile	
Tunnel Limit	Enter the maximum number of tunnels allowed open at one time. For additional GTP tunnels to be opened, existing tunnels must first be closed. This feature can help prevent a form of denial of service attack on your network. This attack involves opening more tunnels than the network can handle and consuming all the network resources doing so. By limiting the number of tunnels at any one time, this form of attack will be avoided. The tunnel limiting applies to the Handover Group, and Authorized SGSNs and GGSNs.
Tunnel Timeout	Enter the maximum number of seconds that a GTP tunnel is allowed to remain active. After the timeout the unit deletes GTP tunnels that have stopped processing data. A GTP tunnel may hang for various reasons. For example, during the GTP tunnel tear-down stage, the "delete pdap context response" message may get lost. By setting a timeout value, you can configure the FortiOS Carrier firewall to remove the hanging tunnels. The default is 86400 seconds, or 24 hours.
Control plane message rate limit	Enter the number of packets per second to limit the traffic rate to protect the GSNs from possible Denial of Service (DoS) attacks. The default limit of **0** does not limit the message rate. GTP DoS attacks can include: • **Border gateway bandwidth saturation**: A malicious operator can connect to your GRX and generate high traffic towards your Border Gateway to consume all the bandwidth. • **GTP flood**: A GSN can be flooded by illegitimate traffic
Handover Group	Select the allowed list of IP addresses allowed to take over a GTP session when the mobile device moves locations. Handover is a fundamental feature of GPRS/UMTS, which enables subscribers to seamlessly move from one area of coverage to another with no interruption of active sessions. Session hijacking can come from the SGSN or the GGSN, where a fraudulent GSN can intercept another GSN and redirect traffic to it. This can be exploited to hijack GTP tunnels or cause a denial of service. When the handover group is defined it acts like a white list with an implicit default deny at the end — the GTP address must be in the group or the GTP message will be blocked. This stops handover requests from untrusted GSNs.

General Settings section of the New GTP Profile	
Authorized SGSNs	Use **Authorized SGSNs** to only allow authorized SGSNs to send packets through the unit and to block unauthorized SGSNs. Go to **Firewall Objects > Address > Addresses** and add the IP addresses of the authorized SGSNs to a firewall address or address group. Then set **Authorized SGSNs** to this firewall address or address group. You can use **Authorized SGSNs** to allow packets from SGSNs that have a roaming agreement with your organization.
Authorized GGSNs	Use **Authorized GGSNs** to only allow authorized GGSNs to send packets through the unit and to block unauthorized GGSNs. Go to **Firewall Objects > Address > Addresses** and add the IP addresses of the authorized GGSNs to a firewall address or address group. Then set **Authorized GGSNs** to this firewall address or address group. You can use Authorized GGSNs to allow packets from SGSNs that have a roaming agreement with your organization.

Message type filtering options

On the **New GTP Profile** page, you can select to allow or deny the different types of GTP messages, which is referred to as message type filtering. You must expand the Message Type Filtering section to access the settings.

The messages types include Path Management, Tunnel Management, Location Management, Mobility Management, MBMS, and GTP-U and Charging Management messages.

For enhanced security, Fortinet best practices dictate that you set Unknown Message Action to deny. This will block all unknown GTP message types, some of which may be malicious.

To configure message type filter options, expand **Message Type Filtering** in the GTP profile.

APN filtering options

An Access Point Name (APN) is an Information Element (IE) included in the header of a GTP packet. It provides information on how to reach a network.

An APN has the following format:

```
<network_id>[.mnc<mnc_int>.mcc<mcc_int>.gprs]
```

Where:

- `<network_id>` is a network identifier or name that identifies the name of a network, for example, `example.com` or `internet`.
- `[.mnc<mnc_int>.mcc<mcc_int>.gprs]` is the optional operator identifier that uniquely identifies the operator's PLMN, for example `mnc123.mcc456.gprs`.

Combining these two examples results in a complete APN of `internet.mnc123.mcc456.gprs`.

By default, the unit permits all APNs. However, you can configure APN filtering to restrict roaming subscribers' access to external networks.

APN filtering applies only to the GTP **create pdp request** messages. The unit inspects GTP packets for both APN and selected modes. If both parameters match and APN filter entry, the unit applies the filter to the traffic.

Additionally, the unit can filter GTP packets based on the combination of an IMSI prefix and an APN.

You cannot add an APN when creating a new profile.

APN Filtering	
Enable APN Filter	Select to enable APN filtering.
Default APN Action	Select the default action for APN filtering. If you select **Allow**, all sessions are allowed except those blocked by individual APN filters. If you select **Deny**, all sessions are blocked except those allowed by individual APN filters.
Value	The APN to be filtered.
Mode	The type of mode chosen that indicates where the APN originated and whether the Home Location Register (HLR) has verified the user subscription:
Action	The type of action that will be taken.
Edit	Modifies the settings within the filter. When you select **Edit**, the Edit window appears, which allows you to modify the settings of the APN.
Delete	Removes the APN from the list within the table, in the APN Filtering section.
Add APN	Adds a new APN filter to the list. When you select **Add APN**, the New window appears, which allows you to configure the APN settings.
New APN page	
Value	Enter an APN to be filtered. You can include wild cards to match multiple APNs. For example, the value **internet*** would match all APNs that being with **internet**.
Mode	Select one or more of the available modes to indicate where the APN originated and whether the Home Location Register (HLR) has verified the user subscription.

Mobile Station provided	MS-provided APN, subscription not verified, indicates that the mobile station (MS) provided the APN and that the HLR did not verify the user's subscription to the network.
Network provided	Network-provided APN, subscription not verified, indicates that the network provided a default APN because the MS did not specify one, and that the HLR did not verify the user's subscription to the network.
Subscription Verified	MS or Network-provided APN, subscription verified, indicates that the MS or the network provided the APN and that the HLR verified the user's subscription to the network
Action	Select **Allow** or **Deny**.

Basic filtering options

The International Mobile Station Identity (IMSI) is used by a GPRS Support Node (GSN) to identify a mobile station. Three elements make up every IMSI:

- the mobile country code (MCC)
- the mobile network code (MNC)
- the mobile subscriber identification number (MSIN).

The subscriber's home network—the public land mobile network (PLMN)—is identified by the IMSI prefix, formed by combining the MCC and MNC.

By default, the unit allows all IMSIs. You can add IMSI prefixes to deny GTP traffic coming from non-roaming partners. Any GTP packets with IMSI prefixes not matching the prefixes you set will be dropped. GTP **Create pdp** request messages are filtered and only IMSI prefixes matching the ones you set are permitted. Each GTP profile can have up to 1000 IMSI prefixes set.

An IMSI prefix and an APN can be used together to filter GTP packets if you set an IMSI filter entry with a non-empty APN.

You cannot add an IMSI when creating a new profile. You must add it after the profile has been created and you are editing the profile.

IMSI Filtering section of the New GTP Profile	
Enable IMSI Filter	Select to enable IMSI filtering.
Default IMSI Action	Select the default action for IMSI filtering. If you select **Allow**, all sessions are allowed except those blocked by individual IMSI filters. If you select **Deny**, all sessions are blocked except those allowed by individual IMSI filters.
APN	The APN that is part of the IMSI that will be filtered.

MCC-MNC	The MCC-MNC part of the IMSI that will be filtered.
Mode	The type of mode that indicates where the APN originated and whether the Home Location Register (HLR) has verified the user subscription.
Action	The type of action that will be taken.
Edit	Modifies settings to an IMSI filter. When you select **Edit**, the Edit window appears, which allows you to modify the IMSI filter's settings.
Delete	Removes an IMSI filter from within the table, in the IMSI Filtering section.
Add IMSI	Adds a new IMSI filter to the list. When you select **Add IMSI**, the New window appears, which allows you to configure IMSI filter settings.
New IMSI page	
APN	Enter the APN part of the IMSI to be filtered.
MCC-MNC	Enter the MCC-MCC part of the IMSI to be filtered.
Mode	Select one or more of the available modes to indicate where the APN originated and whether the Home Location Register (HLR) has verified the user subscription.
Mobile Station provided	MS-provided APN, subscription not verified, indicates that the mobile station (MS) provided the APN and that the HLR did not verify the user's subscription to the network.
Network provided	Network-provided APN, subscription not verified, indicates that the network provided a default APN because the MS did not specify one, and that the HLR did not verify the user's subscription to the network.
Subscription Verified	MS or Network-provided APN, subscription verified, indicates that the MS or the network provided the APN and that the HLR verified the user's subscription to the network
Action	Select **Allow** or **Deny**.

Advanced filtering options

The FortiOS Carrier firewall supports advanced filtering against the attributes RAT, RAI, ULI, APN restriction, and IMEI-SV in GTP to block specific harmful GPRS traffic and GPRS roaming traffic. The following table shows some of the GTP context requests and responses that the firewall supports.

Attributes supported by FortiCarrier firewalls

	GTP Create PDP Context Request	GTP Create PDP Context Response	GTP Update PDP Context Request	GTP Update PDP Context Response
APN	yes	yes	-	
APN Restriction	yes	-	-	yes
IMEI-SV	yes	-	-	-
IMSI	yes	-	yes	-
RAI	yes	-	yes	-
RAT	yes	-	yes	-
ULI	yes	-	yes	-

When editing a GTP profile, select **Advanced Filtering > Create New** to create and add a rule. When the rule matches traffic it will either allow or deny that traffic as selected in the rule.

Advanced Filtering	
Enable	Select to enable advanced filtering.
Default Action	Select the default action for advanced filtering. If you select **Allow**, all sessions are allowed except those blocked by individual advanced filters. If you select **Deny**, all sessions are blocked except those allowed by individual advanced filters.
Messages	The messages, for example, Create PDP Context Request.
APN Restriction	The APN restriction.
RAT Type	The RAT types associated with that filter.
ULI	The ULI pattern.
RAI	The RAI pattern.
IMEI	The IMEI pattern.
Action	The action that will be taken.
Edit	Modifies the filter's settings. When you select **Edit**, the Edit window appears, which allows you to modify the filter's settings.

Delete	Removes a filter from the list.
Add	Adds a filter to the list. When you select **Add**, the New window appears, which allows you to configure settings for messages, APN, IMSI, MSISDN, RAT type, ULI, RAI, IMEI patterns as well as the type of action.
New Filtering page	
Messages	The PDP content messages this profile will match.
Create PDP Context Request	Select to allow create PDP context requests.
Create PDP Context Response	Select to allow create PDP context responses.
Update PDP Context Request	Select to allow update PDP context requests.
Update PDP Context Response	Select to allow update PDP context responses.
APN	Enter the APN.
APN Mode	Select an APN mode as one or more of • Mobile Station provided • Network provided • Subscription provided This field is only available when an APN has been entered.
Mobile Station provided	MS-provided PAN, subscription not verified, indicates that the mobile station (MS) provided the APN and that the HLR did not verify the user's subscription to the network.
Network provided	Network-provided APN, subscription not verified, indicates that the network provided a default APN because the MS did not specify one, and that the HLR did no verify the user's subscription to the network.
Subscription verified	MS or Network-provided APN, subscription verified, indicates that the MS or the network provided the APN and that the HLR verified the user's subscription to the network.

APN Restriction	Select the type of restriction that you want. You can choose all of the types, or one of the types. You cannot choose multiple types. Types include: • all • Public-1 • Public-2 • Private-1 • Private-2
IMSI	Enter the IMSI.
MSISDN	Enter the MSISDN.
RAT Type	Optionally select the RAT type as any combination of the following: • Any • UTRAN • GERAN • Wifi • GAN • HSPA Some RAT types are GTPv1 specific.
ULI pattern	Enter the ULI pattern.
RAI pattern	Enter the RAI pattern.
IMEI pattern	Enter the IMEI pattern.
Action	Select either **Allow** or **Deny**.

Adding an advanced filtering rule

When adding a rule, use the following formats:

- Prefix, for example, range 31* for MCC matches MCC from 310 to 319.
- Range, for example, range 310-319 for MCC matches MCC from 310 to 319.
- Mobile Country Code (MCC) consists of three digits. The MCC identifies the country of domicile of the mobile subscriber.
- Mobile Network Code (MNC) consists of two or three digits for GSM/UMTS applications. The MNC identifies the home PLMN of the mobile subscriber. The length of the MNC (two or three digits) depends on the value of the MCC. Best practices dictate not to mix two and three digit MNC codes within a single MCC area.
- Location Area Code (LAC) is a fixed length code (of 2 octets) identifying a location area within a PLMN. This part of the location area identification can be coded using a full hexadecimal representation except for the following reserved hexadecimal values: 0000 and FFFE. These reserved values are used in some special cases when no valid LAI exists in the MS (see 3GPP TS 24.008, 3GPP TS 31.102 and 3GPP TS 51.011).
- Routing Area Code (RAC) of a fixed length code (of 1 octet) identifies a routing area within a location.
- CI or SAC of a fixed length of 2 octets can be coded using a full hexadecimal expression.

- Type Allocation Code (TAC) has a length of 8 digits.
- Serial Number (SNR) is an individual serial number identifying each equipment within each TAC. SNR has a length of 6 digits.
- Software Version Number (SVN) identifies the software version number of the mobile equipment. SVN has a length of 2 digits.

You cannot add an advanced filtering rule when creating a new profile. You must add it after the profile has been created and you are editing the profile.

Information Element (IE) removal policy options

In some roaming scenarios, the unit is installed on the border of the PLMN and the GRX. In this configuration, the unit supports information element (IE) removal policies to remove any combination of R6 IEs (RAT, RAI, ULI, IMEI-SV and APN restrictions) from the types of messages described in "Advanced filtering options", prior to forwarding the messages to the HGGSN (proxy mode).

IE removal policy	
Enable	Select to enable this option.
SGSN address of message IE	The firewall address or address group that contains the SGSN addresses.
IEs to be removed	The IE types that will be removed. These include APN Restriction, RAT, RAI, ULI, and IMEI.
Add	Adds an IE removal policy. When you select **Add**, the New window appears, which allows you to configure the IE policy.
Edit	Modifies settings from within the IE removal policy. When you select **Edit**, the Edit window appears, which allows you to modify the settings within the policy.
Delete	Removes the IE removal policy from the list.
New IE policy page	
SGSN address	Select a firewall address or address group that contains SGSN addresses.
IEs to be removed	Select one or more IE types to be removed. These include APN Restriction, RAT, RAI, ULI, and IMEI.

Encapsulated IP traffic filtering options

You can use encapsulated IP traffic filtering to filter GTP sessions based on information contained in the data stream. to control data flows within your infrastructure. You can configure IP filtering rules to filter encapsulated

IP traffic from mobile stations by identifying the source and destination policies. For more information, see When to use encapsulated IP traffic filtering.

Expand **Encapsulated IP Traffic Filtering** in the GTP profile to reveal the options.

Encapsulated IP Traffic Filtering	
Enable IP Filter	Select to enable encapsulated IP traffic filtering options.
Default IP Action	Select the default action for encapsulated IP traffic filtering. If you select **Allow**, all sessions are allowed except those blocked by individual encapsulated IP traffic filters. If you select **Deny**, all sessions are blocked except those allowed by individual encapsulated IP traffic filters.
Source	Select a source IP address from the configured firewall IP address or address group lists. Any encapsulated traffic originating from this IP address will be a match if the destination also matches.
Destination	Select a destination IP address from the configured firewall IP address or address group lists. Any encapsulated traffic being sent to this IP address will be a match if the destination also matches.
Action	The type of action that will be taken. Select to **Allow** or **Deny** encapsulated traffic between this source and Destination.
Edit	Modifies the source, destination or action settings.
Add IP Policy	Adds a new encapsulated IP traffic filter. When you select **Add IP Policy**, the New window appears which allows you to configure IP policy settings.
New (window)	
Source	Select the source firewall address or address group.
Destination	Select the destination firewall address or address group.
Action	Select **Allow** or **Deny**.

Encapsulated non-IP end user traffic filtering options

Depending on the installed environment, it may be beneficial to detect GTP packets that encapsulate non-IP based protocols. You can configure the FortiOS Carrier firewall to permit a list of acceptable protocols, with all other protocols denied.

The encoded protocol is determined in the PDP Type Organization and PDP Type Number fields within the End User Address Information Element. The PDP Type Organization is a 4-bit field that determines if the protocol is part of the ETSI or IETF organizations. Values are zero and one, respectively. The PDP Type field is one byte long. Both GTP specifications list only PPP, with a PDP Type value of one, as a valid ETSI protocol. PDP Types for the IETF values are determined in the “Assigned PPP DLL Protocol Numbers” sections of RFC1700. The PDP

types are compressed, meaning that the most significant byte is skipped, limiting the protocols listed from 0x00 to 0xFF.

Encapsulated Non-IP End User Address Filtering	
Enable Non-IP Filter	Select to enable encapsulated non-IP traffic filtering.
Default Non-IP Action	Select the default action for encapsulated non-IP traffic filtering. If you select **Allow**, all sessions are allowed except those blocked by individual encapsulated non-IP traffic filters. If you select **Deny**, all sessions are blocked except those allowed by individual encapsulated non-IP traffic filters.
Type	The type chosen, **AESTI** or **IETF.**
Start Protocol	The beginning protocol port number range.
End Protocol	The end of the protocol port number range.
Action	The type of action that will be taken.
Edit	Modify a non-IP filter's settings in the list. When you select **Edit**, the Edit window appears, which allows you to modify the Non-IP policy settings.
Delete	Remove a non-IP policy from the list.
Add Non-IP Policy	Add a new encapsulated non-IP traffic filter. When you select **Add Non-IP Policy**, you are automatically redirected to the New page.
New (window)	
Type	Select **AESTI** or **IETF**.
Start Protocol **End Protocol**	Select a start and end protocol from the list of protocols in RFC 1700. Allowed range includes 0 to 255 (0x00 to 0xff). Some common protocols include: • 33 (0x0021) Internet Protocol • 35 (0x0023) OSI Network Layer • 63 (0x003f) NETBIOS Framing • 65 (0x0041) Cisco Systems • 79 (0x004f) IP6 Header Compression • 83 (0x0053) Encryption
Action	Select **Allow** or **Deny**.

Protocol Anomaly prevention options

Use protocol anomaly detection options to detect or deny protocol anomalies according to GTP standards and tunnel state. Protocol anomaly attacks involve malformed or corrupt packets that typically fall outside of the

protocol specifications. Packets cannot pass through if they fail the sanity check.

Protocol Anomaly	
Invalid Reserved Field	GTP version 0 (GSM 09.60) headers specify a number of fields that are marked as "Spare" and contain all ones (1). GTP packets that have different values in these fields are flagged as anomalies. GTP version 1 (GSM 29.060) makes better use of the header space and only has one, 1-bit, reserved field. In the first octet of the GTP version1 header, bit 4 is set to zero.
Reserved IE	Both versions of GTP allow up to 255 different Information Elements (IE). However, a number of Information Elements values are undefined or reserved. Packets with reserved or undefined values will be filtered.
Miss Mandatory IE	GTP packets with missing mandatory Information Elements (IE) will not be passed to the GGSN.
Out of State Message	The GTP protocol requires a certain level of state to be kept by both the GGSN and SGSN. Some message types can only be sent when in a specific GTP state. Packets that do not make sense in the current state are filtered or rejected Both versions of GTP allow up to 255 different message types. However, a number of message type values are undefined or reserved. Best practices dictate that packets with reserved or undefined values will be filtered.
Out of State IE	GTP Packets with out of order Information Elements are discarded.
Spoofed Source Address	The End User Address Information Element in the PDP Context Create & Response messages contain the address that the mobile station (MS) will use on the remote network. If the MS does not have an address, the SGSN will set the End User Address field to zero when sending the initial PDP Context Create message. The PDP Context Response packet from the GGSN will then contain an address to be assigned to the MS. In environments where static addresses are allowed, the MS will relay its address to the SGSN, which will include the address in the PDP Context Create Message. As the MS address is negotiated within the PDP Context creation handshake, any packets originating from the MS that contain a different source address are detected and dropped.

Anti-Overbilling options

You can configure the FortiOS Carrier firewall to prevent over billing subscribers for traffic over the. To enable anti-overbilling, you must configure both the Gn/Gp firewall and the Gi firewall.

Expand **Anti-Overbilling** in the GTP profile to reveal these settings.

Anti-Overbilling	
Gi Firewall IP Address	The IP address of the unit's interface configured as a Gi gateway.
Port	The SG security port number. The default port number is port 21123. Change this number if your system uses a different SG port.
Interface	Select the unit interface configured as a Gi gateway.
Security Context ID	Enter the security context ID. This ID must match the ID entered on the server Gi firewall. The default security context ID is 696.

Log options

All the GTP logs are treated as a subtype of the event logs. To enable GTP logging, you must:

- configure the GTP log settings in a GTP profile

Log	
Log Frequency	Enter the number of messages to drop between logged messages. An overflow of log messages can sometimes occur when logging rate-limited GTP packets exceed their defined threshold. To conserve resources on the syslog server and the Carrier-enabled FortiGate unit, you can specify that some log messages are dropped. For example, if you want only every twentieth message to be logged, set a logging frequency of 20. This way, 20 messages are skipped and the next logged. Acceptable frequency values range from 0 to 2147483674. When set to '0', no messages are skipped.
Forwarded Log	Select to log forwarded GTP packets.
Denied Log	Select to log GTP packets denied or blocked by this GTP profile.
Rate Limited Log	Select to log rate-limited GTP packets.
State Invalid Log	Select to log GTP packets that have failed stateful inspection.
Tunnel Limit Log	Select to log packets dropped because the maximum limit of GTP tunnels for the destination GSN is reached.

Extension Log	Select to log extended information about GTP packets. When enabled, this additional information will be included in log entries: • IMSI • MSISDN • APN • Selection Mode • SGSN address for signaling • SGSN address for user data • GGSN address for signaling • GGSN address for user data
Traffic count Log	Select to log the total number of control and user data messages received from and forwarded to the GGSNs and SGSNs that the unit protects. The unit can report the total number of user data and control messages received from and forwarded to the GGSNs and SGSNs it protects. Alternately, the total size of the user data and control messages can be reported in bytes. The unit differentiates between traffic carried by each GTP tunnel, and also between GTP-User and GTP-Control messages. The number of messages or the number of bytes of data received from and forwarded to the SGSN or GGSN are totaled and logged if a tunnel is deleted. When a tunnel is deleted, the log entry contains: • Timestamp • Interface name (if applicable) • SGSN IP address • GGSN IP address • TID • Tunnel duration time in seconds • Number of messages sent to the SGSN • Number of messages sent to the GGSN

Specifying logging types

You can configure the unit to log GTP packets based on their status with GTP traffic logging.

The status of a GTP packet can be any of the following 5 states:

- **Forwarded** - a packet that the unit transmits because the GTP policy allows it
- **Prohibited** - a packet that the unit drops because the GTP policy denies it
- **Rate-limited** - a packet that the unit drops because it exceeds the maximum rate limit of the destination GSN
- **State-invalid** - a packet that the unit drops because it failed stateful inspection
- **Tunnel-limited** - a packet that the unit drops because the maximum limit of GTP tunnels for the destination GSN is reached.

The following information is contained in each log entry:

- Timestamp
- Source IP address
- Destination IP address
- Tunnel Identifier (TID) or Tunnel Endpoint Identifier (TEID)
- Message type
- Packet status: forwarded, prohibited, state-invalid, rate-limited, or tunnel-limited
- Virtual domain ID or name
- Reason to be denied if applicable.

GTP performance

There are independent Receive and Transmit queues for `gtp-u` process. These queues are and their associated resources are initialized when the ftp-enhance-mode is enabled.

CLI changes under system npu

gtp-enhance-mode

```
config system npu
   set gtp-enhance-mode [enable|disable]
   end
```

This configuration requires a reboot of the device to initialize the changes.

gtp-enhance-cpu-range

This is used to set the CPUs which can process the GTP-U packet inspection.

```
config system npu
   set gtp-enhance-cpu-range [0|1|2]
   end
```

Option	Description
0	Inspect GTPU packets by all CPUs
1	Inspect GTPU packets by Master CPUs
2	Inspect GTPU packets by Slave CPUs

Diagnose commands

diagnose npu np6 hbq-stats [all|np xx]

Used to see the GTP-U packet counter by all NP or the corresponding np.

diagnose npu np6 hbq-stats-clear all /np xx

Used to clear the GTP-U packet counter by all NP or the corresponding np.

Verifying the enhance-mode is disabled

Before execute the test or enable/disable the gtp enhance, first check the gtp-enhance-mode status as in the example below:

```
config system npu
   get
   gtp-enhance-mode: disable
   gtp-enhance-cpu-range: 0
   end
```

If the `gtp-enhance-mode` is `disable`, use the command `diagnose npu np6 hbq-stats all`.

The output will be similar to below:

```
# diagnose npu np6 hbq-stats all
Total :0
```

If the `gtp-enhance-mode` is `enable`, use the command `diagnose npu np6 hbq-stats all`

The output will be similar to below:

```
# diagnose npu np6 hbq-stats all
cpu_ 0:0
cpu_ 1:0
cpu_ 2:0
cpu_ 3:0
cpu_ 4:0
cpu_ 5:0
cpu_ 6:0
cpu_ 7:0
cpu_ 8:0
cpu_ 9:0
cpu_10:0
cpu_11:0
cpu_12:0
cpu_13:0
cpu_14:0
cpu_15:0
cpu_16:0
cpu_17:0
cpu_18:0
cpu_19:0
cpu_20:0
cpu_21:0
cpu_22:0
cpu_23:0
cpu_24:0
cpu_25:0
cpu_26:0
cpu_27:0
cpu_28:0
cpu_29:0
cpu_30:0
cpu_31:0
cpu_32:0
cpu_33:0
cpu_34:0
cpu_35:0
```

```
cpu_36:0
cpu_37:0
cpu_38:0
cpu_39:0
Total :0
```

Sometimes, when loading the new configure file, and the new configure file does not match the old configure file, the `gtp-enhance-mode` status will be confused.

You can see :

```
#config system npu
#get
gtp-enhance-mode: enable
```

but you can also see that

```
diagnose npu np6 hbq-stats all
Total :0
```

This means the `gtp-enhance-mode` is actually set to `disable`.

The inverse is also possible, when you see

```
#config system npu
#get
gtp-enhance-mode: disable
```

but you also see that

```
# diagnose npu np6 hbq-stats all
cpu_ 0:0
...
cpu_39:0
Total :0
```

This means the `gtp-enhance-mode` is actually set to `enable`.

If these combinations occur, just run the command below:

```
config system npu
   set gtp-enhance-mode enable
   end
```

or

```
config system npu
   set gtp-enhance-mode disable
   end
```

Once this is done,reboot the device to let the 2 statuses match.

Configuring GTP on FortiOS Carrier

Configuring GTP support on FortiOS Carrier involves configuring a number of areas of features.

GTP support on the Carrier-enabled FortiGate unit

The FortiCarrier unit needs to have access to all traffic entering and exiting the carrier network for scanning, filtering, and logging purposes. This promotes one of two configurations — hub and spoke, or bookend.

A hub and spoke configuration with the Carrier-enabled FortiGate unit at the hub and the other GPRS devices on the spokes is possible for smaller networks where a lower bandwidth allows you to divide one unit into multiple virtual domains to fill multiple roles on the carrier network. It can be difficult with a single FortiOS Carrier as the hub to ensure all possible entry points to the carrier network are properly protected from potential attacks such as relayed network attacks.

A bookend configuration uses two Carrier-enabled FortiGate units to protect the carrier network between them with high bandwidth traffic. One unit handles traffic from mobile stations, SGSNs, and foreign carriers. The other handles GGSN and data network traffic. Together they ensure the network is secure.

The Carrier-enabled FortiGate unit can access all traffic on the network. It can also verify traffic between devices, and verify that the proper GPRS interface is being used. For example there is no reason for a Gn interface to be used to communicate with a mobile station — the mobile station will not know what to do with the data — so that traffic is blocked.

When you are configuring your Carrier-enabled FortiGate unit's GTP profile, you must first configure the APN. It is critical to GTP communications — no traffic will flow without the APN.

The Carrier-enabled FortiGate unit does more than just forward and route GTP packets over the network. It also performs:

- GTP support on the Carrier-enabled FortiGate unit
- GTP support on the Carrier-enabled FortiGate unit
- GTP support on the Carrier-enabled FortiGate unit
- GTP support on the Carrier-enabled FortiGate unit
- GTP support on the Carrier-enabled FortiGate unit

Packet sanity checking

The FortiOS Carrier firewall checks the following items to determine if a packet confirms to the UDP and GTP standards:

- GTP release version number — must be 0, 1, or 2
- Settings of predefined bits
- Protocol type
- UDP packet length

If the packet in question does not confirm to the standards, the FortiOS Carrier firewall drops the packet, so that the malformed or forged traffic will not be processed.

GTP stateful inspection

Apart from the static inspection (checking the packet header), the FortiOS Carrier firewall performs stateful inspection.

Stateful inspection provides enhanced security by keeping track of communications sessions and packets over a period of time. Both incoming and outgoing packets are examined. Outgoing packets that request specific types of incoming packets are tracked; only those incoming packets constituting a proper response are allowed through the firewall.

The FortiOS Carrier firewall can also index the GTP tunnels to keep track of them.

Using the enhanced Carrier traffic policy, the FortiOS Carrier firewall can block unwanted encapsulated traffic in GTP tunnels, such as infrastructure attacks. Infrastructure attacks involve attempts by an attacker to connect to restricted machines, such as GSN devices, network management systems, or mobile stations. If these attempts to connect are detected, they are to be flagged immediately by the firewall .

Protocol anomaly detection and prevention

The FortiOS Carrier firewall detects and optionally drops protocol anomalies according to GTP standards and specific tunnel states. Protocol anomaly attacks involve malformed or corrupt packets that typically fall outside of protocol specifications. These packets are not seen on a production network. Protocol anomaly attacks exploit poor programming practices when decoding packets, and are typically used to maliciously impair system performance or elevate privileges.

FortiOS Carrier also detects IP address spoofing inside GTP data channel.

See Protocol anomaly detection and prevention.

HA

FortiOS Carrier active-passive HA provides failover protection for the GTP tunnels. This means that an active-passive cluster can provide FortiOS Carrier firewall services even when one of the cluster units encounters a problem that would result in complete loss of connectivity for a stand-alone FortiOS Carrier firewall. This failover protection provides a backup mechanism that can be used to reduce the risk of unexpected downtime, especially for mission-critical environments.

FortiOS HA synchs TCP sessions by default, but UDP sessions are not synchronized by default. However synchronizing a session is only part of the solution if the goal is to continue GTP processing on a synchronized session after a HA switch. For that to be successful we also need to synch the GTP tunnel state. So, once the master completes tunnel setup then the GTP tunnel is synchronized to the slave.

GTP traffic will only flow without interruption on a HA switch if bidirectional GTP policies have been configured: an internal (GTP server) to external (all) UDP port GTP policy, and an external (all) to internal (GTP server) UDP port GTP policy. If either policy is missing then traffic may be interrupted until traffic flows in the opposite direction.

For more information on HA in FortiOS, see the High Availability (HA) Guide or the FortiOS Administration Guide.

Virtual domain support

FortiOS Carrier is suited to both large and smaller carriers. A single Carrier-enabled FortiGate unit can serve either one large carrier, or several smaller ones through virtual domains. As with any FortiGate unit, Carrier-enabled units have the ability to split their resources into multiple virtual units. This allows smaller carriers to use just the resources that they need without wasting the extra. For more information on HA in FortiOS, see the Virtual Domains (VDOMs) Guide.

Configuring General Settings on the Carrier-enabled FortiGate unit

To configure the GTP General Settings, go to **Security Profiles > GTP Profile**, and edit a GTP profile. Expand **General Settings** to configure settings. See General settings options.

GTP Monitor Mode

The `monitor-mode` setting is part of the GTP profile. The setting shows on all GTP profiles and works for all GTP versions.

When this setting is enabled, if a GTP packet is to be dropped due to a GTP deny case such as:

- GTP_DENY
- GTP_RATE_LIMIT
- GTP_STATE_INVALID
- GTP_TUNNEL_LIMIT

instead of being dropped, it will be forwarded and logged with the original deny log message and a "-monitor" suffix (e.g., state-invalid-monitor).

This setting is found in the CLI.

```
config firewall gtp
   edit profile_name
      ...
```

```
    set monitor-mode [disable*|enable]
    ...
    end
end
```

Configuring Encapsulated Filtering in FortiOS Carrier

Encapsulated traffic on the GPRS network can come in a number of forms as it includes traffic that is “wrapped up” in another protocol. This detail is important for firewalls because it requires “unwrapping” to properly scan the data inside. If encapsulated packets are treated as regular packets, that inside layer will never be scanned and may allow malicious data into your network.

On Carrier-enabled FortiGate units, GTP related encapsulated filtering falls under encapsulated IP traffic filtering, and encapsulated non-IP end user address filtering.

Configuring Encapsulated IP Traffic Filtering

Generally there are a very limited number of IP addresses that are allowed to encapsulate GPRS traffic. For example GTP tunnels are a valid type of encapsulation when used properly. This is the GTP tunnel which uses the Gp or Gn interfaces between SGSNs and GGSNs. However, a GTP tunnel within a GTP tunnel is not accessible — FortiOS Carrier will either block or forward the traffic, but is not able to open it for inspection.

The ability to filter GTP sessions is based on information contained in the data stream and provides operators with a powerful mechanism to control data flows within their infrastructure. You can also configure IP filtering rules to filter encapsulated IP traffic from Mobile Stations.

To configure the Encapsulated IP Traffic Filtering, go to **Security Profiles > GTP Profile**, and edit a GTP profile. Expand **Encapsulated IP Traffic Filtering** to configure settings. See Encapsulated IP traffic filtering options.

When to use encapsulated IP traffic filtering

The following are the typical cases that need encapsulated IP traffic filtering:

Mobile station IP pools

In a well-designed network, best practices dictate that the mobile station address pool is to be completely separate from the GPRS network infrastructure range of addresses. Encapsulated IP packets originating from a mobile station will not contain source or destination addresses that fall within the address range of GPRS infrastructures. In addition, traffic originating from the users handset will not have destination/source IP addresses that fall within any Network Management System (NMS) or Charging Gateway (CG) networks.

Communication between mobile stations

Mobile stations on the same GPRS network are not able to communicate with other mobile stations. Best practices dictate that packets containing both source and destination addresses within the mobile station's range of addresses are to be dropped.

Direct mobile device or internet attacks

It may be possible for attackers to wrap attack traffic in GTP protocols and submit the resulting GTP traffic directly to a GPRS network element from their mobile stations or a node on the Internet. It is possible that the receiving SGSN or GGSN would then strip off the GTP header and attempt to route the underlying attack. This

underlying attack could have any destination address and would probably have a source address spoofed as if it were valid from that PLMN.

You cannot add an IE removal policy when you are creating a new profile.

Relayed network attacks

Depending on the destination the attack could be directly routed, such as to another node of the PLMN, or re wrapped in GTP for transmission to any destination on the Internet outside the PLMN depending on the routing table of the GSN enlisted as the unwitting relay.

The relayed attack could have any source or destination addresses and could be any of numerous IP network attacks, such as an attack to hijack a PDP context, or a direct attack against a management interface of a GSN or other device within the PLMN. Best practices dictate that any IP traffic originating on the Internet or from an MS with a destination address within the PLMN is to be filtered.

Configuring Encapsulated Non-IP End User Address Filtering

Much of the traffic on the GPRS network is in the form of IP traffic. However some parts of the network do not used IP based addressing, so the Carrier-enabled FortiGate unit is unable to perform Encapsulated IP Traffic Filtering.

Depending on the installed environment, it may be beneficial to detect GTP packets that encapsulate non-IP based protocols. You can configure the FortiOS Carrier firewall to permit a list of acceptable protocols, with all other protocols denied.

The encoded protocol is determined in the PDP Type Organization and PDP Type Number fields within the End User Address Information Element. The PDP Type Organization is a 4-bit field that determines if the protocol is part of the ETSI or IETF organizations. Values are zero and one, respectively. The PDP Type field is one byte long. Both GTP specifications only list PPP, with a PDP Type value of one, as a valid ETSI protocol. PDP Types for the IETF values are determined in the "Assigned PPP DLL Protocol Numbers" sections of RFC 1700. The PDP types are compressed, meaning that the most significant byte is skipped, limiting the protocols listed from 0x00 to 0xFF.

To configure the Encapsulated Non-IP End User Address Filtering, go to **Security Profiles > GTP Profile**, and edit a GTP profile. Expand **Encapsulated Non-IP End User Address Filtering** to configure settings. See Encapsulated non-IP end user traffic filtering options.

Configuring the Protocol Anomaly feature in FortiOS Carrier

When anomalies do happen, it is possible for the anomaly to interrupt network traffic or consume network resources — if precautions are not taken. Anomalies can be generated by accident or maliciously, but both methods can have the same results — degrading the performance of the carrier network, or worse.

To configure GTP protocol anomalies, go to **Security Profiles > GTP Profile**, and edit a GTP profile. Expand the **Protocol Anomaly** option. See Protocol Anomaly prevention options.

The following are some examples:

- The GTP header specifies the length of the packet excluding the mandatory GTP header. In GTP version 0 (GSM 09.60), the mandatory GTP header size is 20 bytes, whereas GTP version 1 (GSM 29.060) specifies that the

minimum length of the GTP header is 8 bytes. The GTP packet is composed of the header, followed by Information Elements typically presented in a Type-Length-Value format. It is possible for an attacker to create a GTP packet with a GTP header field length that is incompatible with the length of the necessary information elements.

- The same concepts are true for GTP version 2 headers even though there are different fields in them.
- It is similarly possible for an attacker to create a packet with an invalid IE length. Invalid lengths may cause protocol stacks to allocate incorrect amounts of memory, and thereby cause crashes or buffer overflows.

By default the FortiOS Carrier firewall detects these problems, as well as other protocol anomalies, and drops the packets. All protocol anomaly options are set to **Deny** by default. However, you can change the policy to allow them.

Configuring Anti-overbilling in FortiOS Carrier

GPRS over billing attacks can be prevented with a properly configured Carrier-enabled FortiGate unit.

Over billing can occur when a subscriber returns his IP address to the IP pool. Before the billing server closes it, the subscriber's session is still open and vulnerable. If an attacker takes control of the subscriber's IP address, he can send or receive data and the subscriber will be billed for the traffic.

Over billing can also occur when an available IP address is reassigned to a new mobile station (MS). Subsequent traffic by the previous MS may be forwarded to the new MS. The new MS would then be billed for traffic it did not initiate.

Anti-overbilling with FortiOS Carrier

The Carrier-enabled FortiGate unit can be configured to assist with anti-overbilling measures. These measures ensure that the customer is only billed for connection time and data transfer that they actually use.

Anti-overbilling on the Carrier-enabled FortiGate unit involves:

- the administrator configuring the over billing settings in the GTP profile to notify the Gi firewall when a GTP tunnel is deleted
- the unit clearing the sessions when the Gi firewall receives a notification from the Gn/Gp firewall about a GTP tunnel being deleted This way, the Gi firewall prevents over billing by blocking traffic initiated by other users.

The three locations to configure anti-overbilling options include:

- **Network > Interface** — Edit a specific interface. Towards the bottom of the **Edit Interface** page, in the **Status** section, you can toggle **Gi Gatekeeper**.
- **System > Settings** — In the **Gi Gatekeeper Settings** section, set the **Context ID** and **Port** that anti-overbilling will take place on.
- **Security Profiles > GTP Profile** — Edit a specific GTP Profile. In the **Anti-Overbilling** section, edit the **Gi Firewall IP address**, **Port**, **Interface** and **Security Context ID**, to use for anti-overbilling measures.

For detailed options, see Anti-Overbilling options.

Logging events on the Carrier-enabled FortiGate unit

Logging on the Carrier-enabled FortiGate unit is just like logging on any other FortiOS unit. The only difference with FortiOS Carrier is that there are a few additional events that you can log beyond the regular ones. These additional events are covered here.

To change FortiOS Carrier specific logging event settings, go to **Security Profiles > GTP Profile** and edit a GTP profile. Expand the **Log** section to change the settings. For detailed options, see Log options.

The following information is contained in each log entry:

Timestamp	The time and date when the log entry was recorded
Source IP address	The sender's IP address.
Destination IP address	The reciever's IP address. The sender-receiver pair includes a mobile phone on the GPRS local network, and a device on a network external to the GPRS network, such as the Internet.
Tunnel Identifier (TID) **Tunnel Endpoint Identifier (TEID)**	An identifier for the start and endpoints of a GTP tunnel. This information uniquely defines all tunnels. It is important for billing information based on the length of time the tunnel was active and how much data passed over the tunnel.
Message type	For available message types, see Common message types on carrier networks.
Packet status	What action was performed on the packet. This field matches the logging options while you are configuring GTP logging. See Logging events on the Carrier-enabled FortiGate unit on page 127. The status can be one of forwarded, prohibited, state-invalid, rate-limited, or tunnel-limited
Virtual domain ID or name	A Carrier-enabled FortiGate unit can be divided into multiple virtual units, each being a complete and self-contained virtual FortiCarrier unit. This field indicates which virtual domain (VDOM) was responsible for the log entry. If VDOMs are not enabled on your unit, this field will be `root`.
Reason to be denied if applicable	If the packet that generated this log entry was denied or blocked, this field will include what part of FortiOS denied or blocked that packet. Such as firewall, antivirus, webfilter, or spamfilter.

An example of the above log message format is for a Tunnel deleted log entry. When a tunnel is deleted, the log entry contains the following information:

- Timestamp
- Interface name (if applicable)
- SGSN IP address (source IP)
- GGSN IP address (destination IP)
- Tunnel ID
- Tunnel duration time in seconds
- Number of messages sent to the SGSN
- Number of messages sent to the GGSN

GTP message type filtering

FortiOS Carrier supports message filtering in GTP by the type of message.

This section includes:

Common message types on carrier networks

Carrier networks include many types of messages — some concern the network itself, others are content moving across the network, and still others deal with handshaking, billing, or other administration based issues.

GTP contains two major parts GTP for the control plane (GTP-C) and GTP for user data tunnelling (GTP-U). Outside of those areas there are only unknown message types.

GTP-C messages

GTP-C contains the networking layer messages. These address routing, versioning, and other similar low level issues.

When a subscriber requests a Packet Data Protocol (PDP) context, the SGSN will send a create PDP context request GTP-C message to the GGSN giving details of the subscriber's request. The GGSN will then respond with a create PDP context response GTP-C message which will either give details of the PDP context actually activated or will indicate a failure and give a reason for that failure. This is a UDP message on port 212.

GTP-C message types include Path Management Messages, Location Management Messages, and Mobility Management Messages.

Path Management Messages

Path management is used by one GSN to detect if another GSN is alive, or if it has restarted after a failure.

The path management procedure checks if a given GSN is alive or has been restarted after a failure. In case of SGSN restart, all MM and PDP contexts are deleted in the SGSN, since the associated data is stored in a volatile memory. In the case of GGSN restart, all PDP contexts are deleted in the GGSN.

Tunnel Management Messages

The tunnel management procedures are used to create, update, and delete GTP tunnels in order to route IP PDUs between an MS and an external PDN via the GSNs.

The PDP context contains the subscriber's session information when the subscriber has an active session. When a mobile wants to use GPRS, it must first attach and then activate a PDP context. This allocates a PDP context data structure in the SGSN that the subscriber is currently visiting and the GGSN serving the subscriber's access point.

Tunnel management procedures are defined to create, update, and delete tunnels within the GPRS backbone network. A GTP tunnel is used to deliver packets between an SGSN and a GGSN. A GTP tunnel is identified in each GSN node by a TEID, an IP address, and a UDP port number.

Location Management Messages

The location-management procedure is performed during the network-requested PDP context activation procedure if the GGSN does not have an SS7 MAP interface (i.e., Gc interface). It is used to transfer location messages between the GGSN and a GTP-MAP protocol-converting GSN in the GPRS backbone network.

Location management subprocedures are used between a GGSN that does not support an SS7 MAP interface (i.e., Gc interface) and a GTP-MAP protocol-conversing GSN. This GSN supports both Gn and Gc interfaces and is able to perform a protocol conversing between GTP and MAP.

Mobility Management Messages

The MM procedures are used by a new SGSN in order to retrieve the IMSI and the authentication information or MM and PDP context information in an old SGSN. They are performed during the GPRS attach and the inter-SGSN routing update procedures.

The MM procedures are used between SGSNs at the GPRS-attach and inter-SGSN routing update procedures. An identity procedure has been defined to retrieve the IMSI and the authentication information in an old SGSN. This procedure may be performed at the GPRS attach. A recovery procedure enables information related to MM and PDP contexts in an old SGSN to be retrieved. This procedure is started by a new SGSN during an inter-SGSN RA update procedure.

GTP-U messages

GTP-U is focused on user related issues including tunneling, and billing. GTP-U message types include MBMS messages, and GTP-U and Charging Management Messages

MBMS messages

Multimedia Broadcast and Multicast Services (MBMS) have recently begun to be offered over GSM and UMTS networks on UTRAN and GERAN radio access technologies. MBMS is mainly used for mobile TV, using up to four GSM timeslots for one MBMS connection. One MBMS packet flow is replicated by GGSN, SGSN and RNCs.

MBMS is split into the MBMS Bearer Service and the MBMS User Service. The MBMS User Service is basically the MBMS Service Layer and offers a Streaming- and a Download Delivery Method. The Streaming Delivery method can be used for continuous transmissions like Mobile TV services. The Download Method is intended for "Download and Play" services.

GTP-U and Charging Management Messages

SGSNs and GGSNs listen for GTP-U messages on UDP port 2152.

GTP‘ (GTP prime) is used for billing messages. It uses the common GTP messages (GTP Version Not Supported, Echo Request and Echo Response) and adds additional messages related to billing procedures.

Unknown Action messages

If the system doesn’t know what type of message it is, it falls into this category. This is an important category of message because malformed messages may appear and need to be handled with security in mind.

Fortinet best practices dictate that you set **Unknown Action messages** to deny for security reasons.

Configuring message type filtering in FortiOS Carrier

GPRS Tunnelling Protocol (GTP) is a group of IP-based communications protocols used to carry General Packet Radio Service (GPRS) traffic within Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications System (UMTS) networks. It allows carriers to transport actual cellular packets over their network via tunneling.

In the CLI, there is a keyword for each type of GTP message for both message filtering, and for message rate limiting.

GTP message rate limiting is only accessible from the CLI using the command `configure firewall gtp`.

To configure GTP message type filtering - web-based manager

1. Go to **Security Profiles > GTP Profile**.
2. Select **Create New**.
3. Enter a name for this profile such as `msg_type_filtering`.
4. Select **Message Type Filtering** to expand it.
5. For each type of message in the list, select Allow or Deny. All messages are set to Allow by default.

Fortinet best practices dictate that the unknown message action should be set to **Deny** for security reasons as this will block malformed messages.

6. Optionally select and configure any other GTP features for this profile, such as logging.
7. Select **OK** to save the profile.
8. Apply the `msg_type_filtering` profile a security policy configured for GTP tunnel traffic.

To configure GTP message filtering and block Unknown Message Action messages- CLI

```
config firewall gtp
   edit msg_type_filtering
      config message-filter
         set unknown-message-action deny
      next
   end
end
```

Message Type Fields

Each of the following message types can be allowed or denied by your Carrier-enabled FortiGate unit depending on your carrier network and GTP traffic.

Unknown Message Action

Set this message type to deny.

Many attempts to hack into a carrier network will result in this unknown message type and therefore it is denied for security reasons.

Path Management Messages

Message Type	Used by	Description
Echo Request/Response	GTP-C, GTP-U, GTP'	Echo Request is sent on a path to another GSN to determine if the other node is alive. Echo Response is the reply.
Version not Supported	GTP-C, GTP-U, GTP'	There are multiple versions of GTP. Both devices communicating must use the same version of GTP, or this message will be the response.
Support Extension Headers Notification		Extensions are optional parts that a device can choose to support or not. If a device includes these extensions, it must include headers for the extensions to sure ensure proper formatting.

Tunnel Management Messages

Message Type	Used by	Description
Create PDP Context Request/ Response	GTP-C	Sent from an SGSN to a GGSN node as part of a GPRS PDP Context Activation procedure or the Network-Requested PDP Context Activation procedure. A valid request initiates the creation of a tunnel.
Update PDP Context Request/ Response	GTP-C	Used when PDP Context information changes, such as when a mobile device changes location.
Delete PDP Context Request/ Response	GTP-C	Used to terminate a PDP Context, and confirm the context has been deleted.
Create AA PDP Context Request/ Response	GTP-C	Sent as part of the GPRS Anonymous Access PDP Context Activation. It is used to create a tunnel between a context in the SGSN and a context in the GGSN.
Delete AA PDP Context Request/ Response	GTP-C	Sent as part of the GPRS PDP Anonymous Access Context Deactivation procedure to deactivate an activated PDP Context. It contains Cause and Private Extension Information Elements

Message Type	Used by	Description
Error Indication	GTP-U	Sent to the GGSN when a tunnel PDU is received for the following conditions: — No PDP context exists — PDP context is inactive — No MM context exists — GGSN deletes its PDP context when the message is received.
PDU Notification Request/ Response/ Reject Request/ Reject Response	GTP-C	When receiving a Tunneled PDU (T-PDU), the GGSN checks if a PDP context is established for the given PDP address. If no PDP context has been established, the GGSN may initiate the Network-requested PDP Context Activation procedure by sending a PDU Notification Request to the SGSN. **Reject Request -** Sent when the PDP context requested by the GGSN cannot be established.

Location Management Messages

Message Type	Used By	Description
Send Routing Information for GPRS Request/ Response	GTP-C	Sent by the GGSN to obtain location information for the MS. This message type contains the IMSI of the MS and Private Extension.
Failure Report Request/ Response	GTP-C	Sent by the GGSN to the HLR when a PDU reject message is received. The GGSN requests the HLR to set the flag and add the GGSN to the list of nodes to report to when activity from the subscriber that owns the PDP address is detected. The message contains the subscriber IMSI and Private Extension
Note MS GPRS Present Request/ Response	GTP-C	When the HLR receives a message from a mobile with MDFG set, it clears the MDFG and sends the Note MS Present message to all GGSN's in the subscriber's list. This message type contains subscriber IMSI, GSN Address and Private Extension

Mobility Management Messages

Message Type	Used By	Description
Identification Request/Response	GTP-C	Sent by the new SGSN to the old SGSN to request the IMSI for a MS when a GPRS Attach is done with a P-TMSI and the MS has changed SGSNs since the GPRS Detach was done.
SGSN context Request/ Response/ Acknowledge	GTP-C	Sent by the new SGSN to the old SGSN to request the MM and PDP Contexts for the MS.
Forward Relocation Request/ Response/ Complete/ Complete Acknowledge	GTP-C	Indicates mobile activation/deactivation within a Routing Area. This prevents paging of a mobile that is not active (visited VLR rejects calls from the HLR or applies Call Forwarding). Note that the mobile station does not maintain an attach/detach state. SRNS contexts contain for each concerned RAB the sequence numbers of the GTP-PDUs next to be transmitted in uplink and downlink directions.
Relocation Cancel Request/ Response	GTP-C	Send to cancel the relocation of a connection.
Forward SRNS Context/ Context Acknowledge	GTP-C	This procedure may be used to trigger the transfer of SRNS contexts from RNC to CN (PS domain) in case of inter system forward handover.
RAN Information Relay	GTP-C	Forward the Routing Area Network (RAN) information. A Routing Area (RA) is a subset of a GSM Location Area (LA). A RA is served by only one SGSN. Ensures that regular radio contact is maintained by the mobile

MBMS messages

Message Type	Used By	Description
MBMS Notification Request/ Response/ Reject Request/ Reject Response	GTP-C	Notification of the radio access devices.
Create MBMS Context Request/ Response	GTP-C	Request to create an active MBMS context. The context will be pending until the response is received. Once active, the MBMS context allows the MS to receive data from a specific MBMS source

Message Type	Used By	Description
Update MBMS Context Request/ Response	GTP-C	
Delete MBMS Context Request/ Response	GTP-C	Request to deactivate the MBMS context. When the response is received, the MBMS context will be inactive.

GTP-U and Charging Management Messages

Message Type	Used By	Description
G-PDU	GTP-C, GTP-U	GPRS Packet data unit delivery message.
Node Alive Request/Response	GTP-C, GTP-U	Used to inform rest of network when a node starts service.
Redirection Request/Response	GTP-C, GTP-U	Used to divert the flow of CDRs from the CDFs to another CGF when the sender is being removed, or they are used when the CGF has lost its connection to a downstream system.
Data Record Transfer Request/Response	GTP-C, GTP-U	Used to reliably transport CDRs from the point of generation (SGSN/GGSN) to non-volatile storage in the CGF

GTP identity filtering

FortiOS Carrier supports a number of filtering methods based on subscriber identity such as APN filtering, IMSI filtering, and advanced filtering.

This section includes:

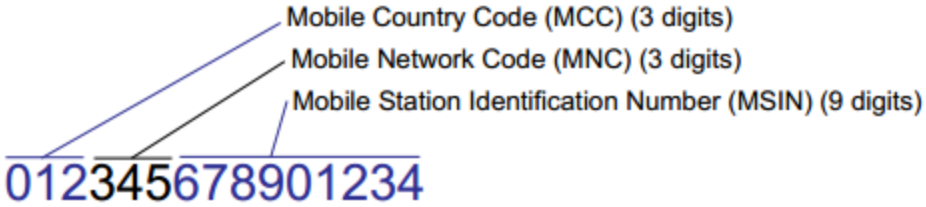
IMSI on carrier networks

The International Mobile Subscriber Identity (IMSI) number is central to identifying users on a carrier network. It is a unique number that is assigned to a cell phone or mobile device to identify it on the GMS or UTMS network.

Typical the IMSI number is stored on the SIM card of the mobile device and is sent to the network as required.

An IMSI number is 15 digits long, and includes the Mobile Country Code (MCC), Mobile Network Code (MNC), and Mobile Station Identification Number (MSIN).

IMSI codes



The Home Network Identity (HNI) is made up of the MCC and MNC. The HNI is used to fully identify a user's home network. This is important because some large countries have more than one country code for a single carrier. For example a customer with a mobile carrier on the East Coast of the United States would have a different MCC than a customer on the West Coast with the same carrier because even through the MNC would be the same the MCC would be different — the United States uses MCCs 310 to 316 due to its size.

If an IMSI number is not from the local carrier's network, IMSI analysis is performed to resolve the number into a Global Title which is used to access the user's information remotely on their home carrier's network for things like billing and international roaming.

Other identity and location based information elements

IMSI focuses on the user, their location, and carrier network. There are other numbers used to identify different user related Information Elements (IE).

These identity and location based elements include:

- Access Point Number (APN)
- Mobile Subscriber Integrated Services Digital Network (MSISDN)
- Radio Access Technology (RAT) type
- User Location Information (ULI)

- Routing Area Identifier (RAI)
- International Mobile Equipment Identity (IMEI)

Access Point Number (APN)

The Access Point Number (APN) is used in GPRS networks to identify an IP packet data network that a user wants to communicate with. The Network Identifier describes the network and optionally the service on that network that the GGSN is connected to. The APN also includes the MCC and MCN, which together locate the network the GGSN belongs to. An example of an APN in the Barbados using Digicel as the carrier that is connecting to the Internet is `internet.mcc342.mnc750.gprs`.

When you are configuring your Carrier-enabled FortiGate unit's GTP profiles, you must first configure the APN. It is critical to GTP communications and without it no traffic will flow.

The access point can then be used in a DNS query to a private DNS network. This process (called APN resolution) gives the IP address of the GGSN which serves the access point. At this point a PDP context can be activated.

Mobile Subscriber Integrated Services Digital Network (MSISDN)

This is a 15-digit number that, along with the IMSI, uniquely identifies a mobile user. Normally this number includes a 2-digit country code, a 3-digit national destination code, and a 10-digit subscriber number or the phone number of the mobile device, and because of that may change over time if the user changes their phone number. The MSISDN number follows the ITU-T E.164 numbering plan.

Radio Access Technology (RAT) type

The RAT type represents the radio technology used by the mobile device. This can be useful in determining what services or content can be sent to a specific mobile device. FortiOS Carrier supports:

- **UMTS Terrestrial Radio Access Network (UTRAN)**, commonly referred to as 3G, routes many types of traffic including IP traffic. This is one of the faster types.
- **GSM EDGE Radio Access Network (GERAN)** is a key part of the GSM network which routes both phone calls and data.
- **Wireless LAN (WLAN)** is used but not as widely as the other types. It is possible for the mobile device to move from one WLAN to another such as from an internal WLAN to a commercial hot spot.
- **Generic Access Network (GAN)** can also be called unlicensed mobile access (UMA). It routes voice, data, and SIP over IP networks. GAN is commonly used for mobile devices that have a dual-mode and can hand-off between GSM and WLANs.
- **High Speed Packet Access (HSPA)** includes two other protocols High Speed Downlink and Uplink Packet Access protocols (HSDPA and HSUPA respectively). It improves on the older WCDMA protocols by better using the radio bandwidth between the mobile device and the radio tower. This results in an increased data transfer rate for the user.

RAT type is part of advanced filtering configuration. See Configuring advanced filtering in FortiOS Carrier.

User Location Information (ULI)

Gives Cell Global Identity/Service Area Identity (CGI/SAI) of where the mobile station is currently located. The ULI and the RAI are commonly used together to identify the location of the mobile device.

ULI is part of advanced filtering configuration. See Configuring advanced filtering in FortiOS Carrier.

Routing Area Identifier (RAI)

Routing Areas (RAs) divide the carrier network and each has its own identifier (RAI). When a mobile device moves from one routing area to another, the connection is handled by a different part of the network. There are normally multiple cells in a routing area. There is only one SSGN per routing area. The RAI and ULI are commonly used to determine a user's location.

RAI is part of advanced filtering configuration. See Configuring advanced filtering in FortiOS Carrier.

International Mobile Equipment Identity (IMEI)

IMEI is a unique 15-digit number used to identify mobile devices on mobile networks. It is very much like the MAC address of a TCP/IP network card for a computer. It can be used to prevent network access by a stolen phone — the carrier knows the mobile phone's IMEI, and when it is reported stolen that IMEI is blocked from accessing the carrier network no matter if it has the same SIM card as before or not. It is important to note that the IMEI stays with the mobile phone or device where the other information is either location based or stored on the removable SIM card.

IMEI type is part of advanced filtering configuration. See Configuring advanced filtering in FortiOS Carrier.

When to use APN, IMSI, or advanced filtering

At first glance APN, IMSI, and advanced filtering have parts in common. For example two can filter on APN, and another two can filter on IMSI. The difficulty is knowing when to use which type of filtering.

Identity filtering comparison

Filtering type	Filter on the following data:	When to use this type of filtering
APN	APN	Filter based on GTP tunnel start or destination
IMSI	IMSI, MCC-MNC	Filter based on subscriber information
Advanced	PDP context, APN, IMSI, MSISDN, RAT type, ULI, RAI, IMEI	When you want to filter based on: • user phone number (MSISDN) • what wireless technology the user employed • to get on the network (RAT type) • user location (ULI and RAI) • handset ID, such as for stolen phones (IMEI)

APN filtering is very specific — the only identifying information that is used to filter is the APN itself. This will always be present in GTP tunnel traffic, so all GTP traffic can be filtered using this value.

IMSI filtering can use a combination of the APN and MCC-MNC numbers. The MCC and MNC are part of the APN, however filtering on MCC-MNC separately allows you to filter based on country and carrier instead of just the destination of the GTP Tunnel.

Advanced filtering can go into much deeper detail covering PDP contexts, MSISDN, IMEI, and more not to mention APN, and IMSI as well. If you can't find the information in APN or IMSI that you need to filter on, then use Advanced filtering.

Configuring APN filtering in FortiOS Carrier

To configure APN filtering go to **Security Profiles > GTP Profile**. Select a profile or create a new one, and expand **APN filtering**.

When you are configuring your Carrier-enabled FortiGate unit's GTP profiles, you must first configure the APN. It is critical to GTP communications and without it no traffic will flow.

Enable APN Filter	Select to enable filtering based on APN value.
Default APN Action	Select either Allow or Deny for all APNs that are not found in the list. The default is Allow.
Value	Displays the APN value for this entry. Partial matches are allowed using wildcard. For example `*.mcc333.mcn111.gprs` would match all APNs from country `333` and carrier `111` on the gprs network.
Mode	Select one or more of the methods used to obtain APN values. Mobile Station provided - The APN comes from the mobile station where the mobile device connected. This is the point of entry into the carrier network for the user's connection. Network provided - The APN comes from the carrier network. Subscription Verified - The user's subscription has been verified for this APN. This is the most secure option.
Action	One of allow or deny to allow or block traffic associated with this APN.
Delete icon	Select to remove this APN entry from the list.
Edit icon	Select to change the information for this APN entry.
Add APN	Select to add an APN to the list. Not active while creating GTP profile, only when editing an existing GTP profile. Save all changes before adding APNs. A warning to this effect will be displayed when you select the **Add APN** button.

The Add APN button is not activated until you save the new GTP profile. When you edit that GTP profile, you will be able to add new APNs.

Configuring IMSI filtering in FortiOS Carrier

In many ways the IMSI on a GPRS network is similar to an IP address on a TCP/IP network. Different parts of the number provide different pieces of information. This concept is used in IMSI filtering on FortiOS Carrier.

To configure IMSI filtering go to **Security Profiles > GTP Profile** and expand **IMSI filtering**.

While both the APN and MCC-MCN fields are optional, without using one of these fields the IMSI entry will not be useful as there is no information for the filter to match.

Enable IMSI Filter	Select to turn on IMSI filtering.
Default IMSI Action	Select Allow or Deny. This action will be applied to all IMSI numbers except as indicated in the IMSI list that is displayed. The default value is Allow.
APN	The Access Point Number (APN) to filter on. This field is optional.
MCC-MNC	The Mobile Country Code (MCC) and Mobile Network Code (MNC) to filter on. Together these numbers uniquely identify the carrier and network of the GGSN being used. This field is optional.
Mode	Select the source of the IMSI information as one or more of the following: **Mobile Station provided -** the IMSI number comes from the mobile station the mobile device is connecting to. **Network provided -** the IMSI number comes from the GPRS network which could be a number of sources such as the SGSN, or HLR. **Subscription Verified -** the IMSI number comes from the user's home network which has verified the information. While Subscription Verified is the most secure option, it may not always be available. Selecting all three options will ensure the most complete coverage.
Action	Select the action to take when this IMSI information is encountered. Select one of Allow or Deny.
Delete Icon	Select the delete icon to remove this IMSI entry.
Edit Icon	Select the edit icon to change information for this IMSI entry.

Add IMSI	Select to add an IMSI to the list. Not active while creating GTP profile, only when editing an existing GTP profile. Save all changes before adding IMSIs. A warning to this effect will be displayed when you select the **Add IMSI** button.

Configuring advanced filtering in FortiOS Carrier

Compared to ADN or IMSI filtering, advanced filtering is well named. Advanced filtering can be viewed as a catch-all filtering option — if ADN or IMSI filtering doesn't do what you want, then advanced filtering will. The advanced filtering can use more information elements to provide considerably more granularity for your filtering.

Enable	Select to turn on advanced filtering.
Default Action	Select Allow or Deny as the default action to take when traffic does not match an entry in the advanced filter list .
Messages	Optionally select one or more types of messages this filter applies to: Create PDP Context Request, Create PDP Context Response, Update PDP Context Request, or Update PDP Context Response. Selecting **Create PDP Context Response** or **Update PDP Context Response limits RAT type to only GAN and HSPA, and disables the APN, APN Mode, IMSI, MSISDN, ULI, RAI,** and **IMEI fields.** To select **Update PDP Context Request**, **APN Restriction** must be set to **all**. Selecting **Update PDP Context Request disables the APN, MSISDN,** and **IMEI fields.** if all message types are selected, only the RAT Types of GAN and HSPA are available to select.
APN Restriction	APN Restriction either allows all APNs or restricts the APNs to one of four categories — Public-1, Public-2, Private-1, or Private-2. This can also be combined with a specific APN or partial APN as well as specifying the APN mode.
RAT Type	Select one or more of the Radio Access Technology Types listed. These fields control how a user accesses the carrier's network. You can select one or more of UTRAN, GERAN, WLAN, GAN, HSPA, or any.
ULI	The user location identifier. Often the ULI is used with the RAI to locate a user geographically on the carrier's network. The ULI is disabled when **Create PDP Context Response** or **Update PDP Context Response** messages are selected.

RAI	The router area identifier. There is only one SGSN per routing area on a carrier network. This is often used with ULI to locate a user geographically on a carrier network. The RAI is disabled when **Create PDP Context Response** or **Update PDP Context Response** messages are selected.
IMEI	The International Mobile Equipment Identity. The IMEI uniquely identifies mobile hardware, and can be used to block stolen equipment. The IMEI is only available when **Create PDP Context Request** or no messages are selected.
Action	Select **Allow** or **Deny** as the action when this filter matches traffic. The default is Allow.
Delete Icon	Select to delete this entry from the list.
Edit Icon	Select to edit this entry.
Add	Select to add an advanced filter to the list. Not active while creating GTP profile, only when editing an existing GTP profile. Save all changes before adding advanced filters. A warning to this effect will be displayed when you select the **Add** button.

SCTP Concepts

As of FortiOS version 5.0, the FortiGate natively handles SCTP (Stream Control Transport Protocol) traffic, as an alternative to TCP and UDP for use in Carrier networks. The FortiGate handles SCTP as if it would any other traffic.

Overview

SCTP is a connection-oriented transport protocol that overcomes some of the limitations of both TCP and UDP that prevent reliable transfer of data over IP-based networks (such as those used by telephony systems and carrier networks). The 'Stream' in SCTP refers to the sequence of user messages or packets that are considered at the same time to be individual objects and also treated as a whole by networked systems. SCTP is less vulnerable to congestion and flooding due to more advanced error handling and flood protection built into the protocol.

SCTP features as compared to TCP and UDP

Feature	SCTP	TCP	UDP
State required at each endpoint	yes	yes	no
Reliable data transfer	yes	yes	no
Congestion control and avoidance	yes	yes	no
Message boundary conservation	yes	no	yes
Path MTU discovery and message fragmentation	yes	yes	no
Message bundling	yes	yes	no
Multi-homed hosts support	yes	no	no
Multi-stream support	yes	no	no
Unordered data delivery	yes	no	yes
Security cookie against SYN flood attack	yes	no	no
Built-in heartbeat (reachability check)	yes	no	N/A

All of these features are built into the design of the Protocol, and the structure of SCTP packets and networks. The FortiGate unit interprets the traffic and provides the necessary support for maintenance and verification features, but the features are not FortiGate specific. These features are documented in greater detail below.

State required at each endpoint

Constant back and forth acknowledgement and content verification messages are sent between all SCTP peer endpoints, and all endpoints' state machine actions must be synchronized for traffic to flow.

Reliable data transfer

SCTP places data and control information (eg. source, destination, verification) into separate messages, both sharing the same header in the same SCTP packet. This allows for constant verification of the contained data at both ends and along the path, preventing data loss or fragmentation. As well, data is not sent in an interruptible stream as in TCP.

Congestion control and avoidance

Built-in, constantly updating path detection and monitoring automatically redirect packets along alternate paths in case of traffic congestion or inaccessible destinations. For deliberate/malicious congestion control, see the below section on Security cookie against SYN flood attack.

Message boundary conservation

SCTP is designed in such a way that no matter how messages are divided, redirected, or fragmented, the message boundaries will be maintained within the packets, and all messages cannot be appended without tripping verification mechanisms.

Path MTU discovery and message fragmentation

SCTP is capable of Path Maximum Transmission Unit discovery, as outlined in RFC4821. Two specific alterations have been made to how SCTP handles MTU. First, that endpoints will have separate MTU estimates for each possible multi-homed endpoint. Second, that bundled message fragments (as explained below) will be directed based on MTU calculations, so that retransmissions (if necessary) will be sent without delay to alternate addresses.

Message bundling

SCTP is a message-oriented protocol, which means that despite being a streaming data protocol, it transports a sequence of specific messages, rather than transporting a stream of bytes (like TCP). Since some data transmissions are small enough to not require a complete message's worth of content, so multiple pieces of content will be transmitted simultaneously within the messages.

Multi-homed hosts support

SCTP supports multi-homing, which is a network structure in which one or multiple sources/destinations has more than one IP address. SCTP can adapt to multi-homing scenarios and redirect traffic to alternate IP addresses in case of failure.

Multi-stream support

Due to the message bundling feature allowing for multiple pieces of content to be sent in messages at once, SCTP can 'multi-stream' content, by deliberately dividing it among messages at a fixed rate, so that multiple types of content (eg. both images and text) can be loaded at once, at the same pace.

Unordered data delivery

With control messages in every packet to provide verification of any packet's data and its place in the stream, the data being transmitted can actually arrive in any order, and verify that all has arrived or that some is missing.

Security cookie against SYN flood attack

Since every packet contains verification of its place in the stream, it makes it easy for the protocol to detect when redundant, corrupted or malicious packets flood the path, and they are automatically dropped when necessary.

Built-in heartbeat (reachability check)

Endpoints automatically send specific control chunks among the other SCTP packet information to peer endpoints, to determine the reachability of the destination. Hearthbeat acknowledgement packets are returned if the destination is available.

SCTP Firewall

FortiGate stateful firewalls will protect and inspect SCTP traffic, according to RFC4960. SCTP over IPsec VPN is also supported. The FortiGate device is inserted as a router between SCTP endpoints. It checks SCTP Syntax for the following information:

- Source and destination port
- Verification Tag
- Chunk type, chunk flags, chunk length
- Sequence of chunk types
- Associations

The firewall also oversees and maintains several SCTP security mechanisms:

- SCTP four-way handshake
- SCTP heartbeat
- NAT over SCTP

The firewall has IPS DoS protection against known threats to SCTP traffic, including INIT/ACK flood attacks, and SCTP fuzzing.

Troubleshooting

This section offers troubleshooting options for Carrier-related issues.

This section includes:

FortiOS Carrier diagnose commands

This section includes diagnose commands specific to FortiOS Carrier features such as GTP.

GTP related diagnose commands

This CLI command allows you to gain information on GTP packets, logs, statistics, and other information.

```
diag firewall gtp <command>
```

apn list <gtp_profile>	The APN list entries in the specified GTP profile
auth-ggsns show <gtp_profile>	The authorized GGSNs entries for the specified GTP profile. Any GGSNs not on this list will not be recognized.
auth-sgsns show <gtp_profile>	The authorized SGSNs list entries for the specified GTP profile. Any SGSNs not on this list will not be recognized.
handover-grp show <gtp_ profile>	The handover group showing the range of allowed handover group IP addresses. The handover group acts like a white list of allowed GTP addresses with a default deny at the end — if the GTP address is not on the list, it is denied.
ie-remove-policy list <gtp_ profile>	List of IE policies in the IE removal policy for this GTP profile. The information displayed includes the message count for this policy, the length of the SGSN, the list of IEs, and list of SGSN IP addresses.
imsi list <gtp_profile>	IMSI filter entries for this GTP profile. The information displayed includes the message count for this filter, length of the IMSI, the length of the APN and IMSI, and of course the IMSI and APN values.
invalid-sgsns-to-long list <gtp_ profile>	List of SGSNs that do not match the filter criteria. These SGSNs will be logged.
ip-policy list <gtp_profile>	List the IP policies including message count for each policy, the action to take, the source and destination IP addresses or ranges, and masks.

noip-policy <gtp_profile>	List the non-IP policies including the message count, which mode, the action to take, and the start and end protocols to be used by decimal number.
path {list | flush}	Select list or flush. List the GTP related paths in FortiOS Carrier memory. Flush the GTP related paths from memory.
policy list <gtp_policy>	The GTP advanced filter policy information for this GTP profile. The information displayed for each entry includes a count for messages matching this filter, a hexidecimal mask of which message types to match, the associated flags, action to take on a match, APN selection mode, MSISDN, RAT types, RAI, ULI, and IMEI.
profile list	Displays information about the configured GTP profiles. You will not be able to see the bulk of the information if you do not log the output to a file.
runtime-stat flush	Select to flush the GTP runtime statistics from memory.
stat	Display the GTP runtime statistics — details on current GTP activity. This information includes how many tunnels are active, how many GTP profiles exist, how many IMSI filter entries, how many APN filter entries, advanced policy filter entries, IE remove policy filter entries, IP policy filter entries, clashes, and dropped packets.
tunnel {list | flush}	Select one of list or flush. List lists all the GTP tunnels currently active. Flush clears the list of active GTP tunnels. This does not clear the clash counter displayed in the `stat` command.

Applying IPS signatures to IP packets within GTP-U tunnels

GTP-U (GTP user data tunnelling) tunnels carry user data packets, signaling messages and error information. GTP-U uses UDP port 2152. Carrier-enabled FortiGate units can apply IPS intrusion protection and detection to GTP-U user data sessions.

To apply IPS to GTP-U user data sessions, add an IPS Sensor to a profile and add the profile to a security policy that accepts GTP-U tunnels. The security policy Service field must be set to GTP or ANY to accept GTP-U packets.

The Carrier-enabled FortiGate unit intercepts packets with destination port 2152, removes the GTP header and handles the packets as regular IP packets. Applying an IPS sensor to the IP packets, the Carrier-enabled FortiGate unit can log attacks and pass or drop packets depending on the configuration of the sensor.

If the packet is GTP-in-GTP, or a nested tunnel, the packets are passed or blocked without being inspected.

To apply an IPS sensor to GTP-U tunnels

1. Go to **Security Profiles > Intrusion Protection** and select Create New (**+**) to add an IPS Sensor.
2. Configure the IPS Sensor to detect attacks and log, drop, or pass attack packets.
   See the Intrusion Protection section of the FortiOS UTM Guide.
3. Go to **Policy & Objects > IPv4 Policy** and apply the IPS sensor to the security policy.
4. Go to **Policy & Objects > IPv4 Policy** and select Create New to add a security policy or select a security policy.
5. Configure the security policy to accept GTP traffic.
   In the security policy configure the source and destination settings to match the GTP traffic. Service to GTP or ANY so that the security policy accepts GTP traffic.
6. Select the GTP profile within the security policy.
7. Configure any other required security policy settings.
8. Select **OK** to save the security policy.

GTP packets are not moving along your network

When GTP packets are not getting to their destination, this could be caused by any one of a number of issues. General troubleshooting principals apply here.

The following sections provide some suggestions on how to troubleshoot this issue:

- Attempt to identify the section of your network with the problem
- Ensure you have an APN configured
- Check the logs and adjust their settings if required
- Check the routing table
- Perform a sniffer trace
- Generate specific packets to test the network

Attempt to identify the section of your network with the problem

The first step is to determine how widespread this problem is. Does it affect the whole GPRS network, or just one or two devices?

If the entire network is has this problem, the solution is likely a more general one such as ensuring the security policies allow GTP traffic to pass, the GTP profile specifies SSGNs and GSGNs, or ensuring the GTP general settings are not overly limiting.

If one part of the network is affected, the problem is more likely centered around configurations with those network devices specified such as the handover group, or authorized SGSNs/GGSNs. It is also possible that small portions of the network may have hardware related issues such as cabling or faulty hardware. This section does not address those issues, and assumes hardware is not the problem.

The handover group is a white list of GTP addresses allowed to handle GTP messages. If a device's address is not on this list, it will be denied.

Ensure you have an APN configured

When you configure your GTP profile, ensure you first configure the APN. Without it, there will be no flow of traffic. The APN is used in nearly all GTP communications and without it, the Carrier-enabled FortiGate unit doesn't have the information it needs.

Check the logs and adjust their settings if required

During normal operation, the log settings will show any problems on the network but may not provide the level of details required to fully troubleshoot the problem. The reason for this is that the level of detail required for troubleshooting would quickly overwhelm the daily logs without any real benefit.

GTP related events in the event log will have message IDs in the range 41216 to 41222. For more information on GTP log messages, see the Log Message Reference. For more information on logging in general, see the Logging and Reporting guide.

Once there is a problem to troubleshoot, check the logs to trace the traffic patterns and narrow down the possible sources of the problem. There may be enough detail for you to locate and fix the problem without changing the log settings.

Remember to set any changes you made to the log settings back to their original values when you are done troubleshooting. Otherwise, the amount of detail will overwhelm your logging.

However, if more detail is required you can change settings such as:

- Lower the Log Frequency number in GTP Profiles so fewer or no log messages are dropped. This will allow a more accurate picture of everything happening on the network, where you may have had only a partial picture before.
- Ensure all the GTP log events are enabled to provide you with a complete picture.
- Ensure that all relevant event types are enabled under **Log & Report > Log Config > Log Settings.**

For more information on GTP related logging, see Logging events on the Carrier-enabled FortiGate unit.

General information to look for in the logs includes:

- Are all packets having problems or just certain types?
- Are all devices on the network having problem, or just certain devices?
- Is it just GTP traffic that is having problems or are all types of traffic having the same problem?

Check the routing table

On any network, the routing table determines how packets reach their destination. This is also true on a carrier network.

If the Carrier-enabled FortiGate unit is running in NAT mode, verify that all desired routes are in the routing table — local subnets, default routes, specific static routes, and dynamic routing protocols. For complete information, it is best to check the routing table in the CLI. This method provides more complete information.

If VDOMs are enabled on your Carrier-enabled FortiGate unit, all routing related CLI commands must be performed within a VDOM and not in the global context.

To check the routing table using the CLI

```
# get router info routing-table all
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default

S* 0.0.0.0/0 [10/0] via 192.168.183.254, port2
S 1.0.0.0/8 [10/0] via 192.168.183.254, port2
S 2.0.0.0/8 [10/0] via 192.168.183.254, port2
C 10.142.0.0/23 is directly connected, port3
B 10.160.0.0/23 [20/0] via 10.142.0.74, port3, 2d18h02m
C 192.168.182.0/23 is directly connected, port2
```

Examining an entry from the routing table above:

```
B 10.160.0.0/23 [20/0] via 10.142.0.74, port3, 2d18h02m
```

B	BGP. The routing protocol used.
10.160.0.0/23	The destination of this route including netmask.
[20/0]	20 indicates and administrative distance of 20 out of a range of 0 to 255. 0 is an additional metric associated with this route, such as in OSPF
10.142.0.74	The gateway, or next hop.
port3	The interface used by this route.
2d18h02m	How old this route is, in this case almost three days old.

Perform a sniffer trace

When troubleshooting network traffic, it helps to look inside the headers of packets to determine if they are traveling along the route you expect. Packet sniffing can also be called a network tap, packet capture, or logic analyzing.

If your Carrier-enabled FortiGate unit has NP interfaces that are offloading traffic, this will change the sniffer trace. Before performing a trace on any NP interfaces, disable offloading on those interfaces.

What can sniffing packets tell you

If you are running a constant traffic application such as ping, packet sniffing can tell you if the traffic is reaching the destination, what the port of entry is on the Carrier-enabled FortiGate unit, if the ARP resolution is correct, and if the traffic is being sent back to the source as expected.

Sniffing packets can also tell you if the Carrier-enabled FortiGate unit is silently dropping packets for reasons such as RPF (Reverse Path Forwarding), also called Anti Spoofing. This prevents an IP packet from being forwarded if its source IP address either does not belong to a locally attached subnet (local interface), or be a hop on the routing between the FortiOS Carrier and another source (static route, RIP, OSPF, BGP). Note that RPF can be disabled by turning on asymmetric routing in the CLI (`config system setting, set asymmetric enable`), however this will disable stateful inspection on the Carrier-enabled FortiGate unit and consequently cause many features to be turned off.

If you configure virtual IP addresses on your Carrier-enabled FortiGate unit, the unit will use those addresses in preference to the physical IP addresses. If not configured properly, secondary IP addresses can cause a broadcast storm. You will notice the secondary address being preferred when you are sniffing packets because all the traffic will be using the virtual IP addresses. This is due to the ARP update that is sent out when the VIP address is configured.

How to sniff packets

The general form of the internal FortiOS packet sniffer command is:

```
diag sniffer packet <interface_name> <'filter'> <verbose> <count>
```

To stop the sniffer, type `CTRL+C`.

<interface_name>	The name of the interface to sniff, such as `port1` or `internal`. This can also be `any` to sniff all interfaces.
<'filter'>	What to look for in the information the sniffer reads. `none` indicates no filtering, and all packets will be displayed as the other arguments indicate. The filter must be inside single quotes (‘).
<verbose>	The level of verbosity as one of: **1 -** print header of packets **2 -** print header and data from IP of packets **3 -** print header and data from Ethernet of packets
<count>	The number of packets the sniffer reads before stopping. If you don’t put a number here, the sniffer will run forever unit you stop it with `<CTRL C>`.

For a simple sniffing example, enter the CLI command `diag sniffer packet port1 none 1 3`. This will display the next 3 packets on the port1 interface using no filtering, and using verbose level 1. At this verbosity level you can see the source IP and port, the destination IP and port, action (such as ack), and sequence numbers.

In the output below, port 443 indicates these are HTTPS packets, and 172.20.120.17 is both sending and receiving traffic.

```
Head_Office_620b # diag sniffer packet port1 none 1 3
interfaces=[port1]
filters=[none]
0.545306 172.20.120.17.52989 -> 172.20.120.141.443: psh 3177924955 ack 1854307757
```

```
0.545963 172.20.120.141.443 -> 172.20.120.17.52989: psh 1854307757 ack 3177925808

0.562409 172.20.120.17.52988 -> 172.20.120.141.443: psh 4225311614 ack 3314279933
```

Generate specific packets to test the network

If some packets are being delivered as expected while others are not, or after you believe you have fixed the problem, it is a good idea to generate specific traffic to test your network.

For example if you discover through log messages and packet sniffing that Create PDP Context Request messages are not being delivered between two SGSNs, you can generate those specific messages on your network to confirm they are the problem, and later that you have solved the problem and they are now being delivered as expected.

This step requires a third party traffic generation tool, either hardware or software. This is not be supported by Fortinet.

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